Report on the Properties and Domain of the California Water Company, Situated on the Georgetown Divide

Amos Bowman

California Water Company

Embracing the Mining, Water and Landed Resources of the Country Between the South and Middle Forks of the American River in El Dorado County,...

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LOON LAKE AND TELL'S MOUNTAIN RANGE.

(See under Physical Geography.)

Jno. B. Mulloy

January 31 1878

REPORT

ON

THE PROPERTIES AND DOMAIN OF THE CALIFORNIA WATER COMPANY,

SITUATED ON

GEORGETOWN DIVIDE:

EMBRACING THE

MINING, WATER AND LANDED RESOURCES OF THE COUNTRY,

BETWEEN THE

South and Middle Forks of the American River, in El Dorado County, California.

BY

AMOS BOWMAN.

SAN FRANCISCO:
A. L. BANCROFT AND COMPANY.
1871.

To the Directors and Stockholders of the California Water Company:

MESSRS. J. P. PIERCE,
J. O. EARL,
ISAAC E DAVIS,
EGBERT JUDSON,
J. S. DOE, ETC., ETC.

Gentlemen:—By desire of the Executive Officers of your Company I devoted ten weeks in the field during June, July, and November of this year to an examination of the Resources, Geography, and Property Developments of the country commanded by the Ditches of the California Water Company, an area of about one thousand square miles, situated between the South and Middle Forks of the American, commonly known as the Georgetown Divide, the results of which are appended.

The conditions of the undertaking, it is proper to remark, necessarily and unavoidably delayed the publication of this report; owing chiefly to the circumstances which rendered it impossible for me to give the subject my continuous and undivided attention.

My acknowledgments, and the thanks of the Company are due to James P. Tolman, C. E., of Boston, volunteer assistant in the field.

Respectfully,

AMOS BOWMAN.

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REPORT.

I.—TREATMENT OF THE SUBJECT.

PHYSICAL GEOGRAPHY, GEOLOGY, WATER, MINING, OTHER RESOURCES, STATISTICS, ETC.

IN treating of the water rights, ditch properties, and the opportunities of the California Water Company in general, I take the liberty of considering the situation in the broadest view, with all the advantages it appears to me to offer, even in untried ways. Scope

I shall show, farther on, how near you are to the possession and control of a supply of water equal, for all practical purposes, and for centuries to come, to Lake Tahoe itself, as an available storage reservoir; what steps must be taken to turn this supply to account; and in the use and application of the water you bring to market, I will not lose sight of it on its first application, but will follow it until it gravitates out of your possession in the levels of the Sacramento plains, or through the drains of Sacramento City. Reserved Water

The market for water is considered primarily under the head of mining. Without a thorough understanding of the various occurrences of gold, and the best data attainable concerning what are the workable quantities of gold, as found by experience in each, it would be difficult for any one, and especially Market—Workable Mines

a non-resident, to arrive at definite or business ideas concerning the situation, and in what manner to take advantage of its particular phases with success.

Physical Conditions.

Having dwelt briefly upon the physical geography of the Divide (which is fundamental to the operations of a Water Company), in Subdivision II, I accordingly furnish, in III, some detailed notes of the mines; and, in IV, facts of a broader yet no less practical bearing, touching their character and relations, whereby they may be intelligently compared with gold mines and mining operations elsewhere.

Characteristics of Mining

Benefiting from Experience.

Your own experience and that of others is made most of in this way; and various methods of successful mining, or successful dealing with water, or prosperous management in a purely business sense, other than those, perhaps, of mere local experience, may suggest themselves and receive your attention, and possibly furnish, or make clearer the key to the situation.

The geological data observed, and presented in this connection, are original, and, it is believed, of some importance, looking toward a more thorough understanding of the conditions of profitable mining on the western slope of the Sierra Nevada generally.

Water Delivery

The fundamental outlines of your field being thus disposed of, I proceed to consider, under V, the instrumentalities and the conditions of water supply, and the details of operations hitherto.

Resources—Statistics

Under VI are mentioned other resources of the domain beside water and mines; and, under VII, statistical data of miscellaneous or general import.

II.—PHYSICAL GEOGRAPHY.

SALIENT FEATURES, GEOGRAPHY,
MOUNTAINS, EROSIONS,
FOREST DISTRIBUTION AND CLIMATE, RAIN AND SNOWFALL,
SEASONS, RAIN ZONES, ETC.

(a).—THE SALIENT FEATURES

OF the region, from the stand-point of water supply, are suggested by observing the existence of a series of natural reservoirs, of which Loon Lake is an example (being usually of glacial origin), situated in the drainage basins of the perpetual snows. Sometimes scooped out of bare rock to a great depth, and surrounded by low and scantily-timbered *roche montonnee*, these lakes are beautifully diversified by rich timber upon the detrital flats, the greenest and freshest of grass and other luxuriant mountain herbage upon the intervening meadows, and by the very peculiar topography of the enclosing moraines; such characteristic features of an Alpine history with colors of green and grey, being mirrored and mingled in rippled silence with the broad, white masses of the surrounding snow peaks. Natural Reservoirs —glacial valleys

The depth of the annual fall of snow in this region is, by gauge measurement, 18 feet; or, reduced to water, 6 feet over the entire area (see rain sections below). And the "snow line," or contour of altitude at which the sun's rays, through the long dry season of summer, fail to bring this quantity of snow to the liquid state before the next season's snows pile on, may be set down at 7,500 feet above the sea. In some years, however, the snow remains lying below 7,000 feet; the snow line oscillating in periods of about ten years. Precipitation and Snow Line.

The ice beds of the cold period of the Post Pliocene,

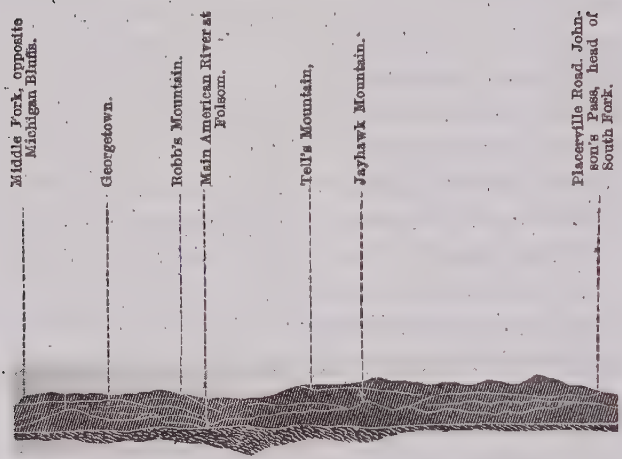
Glacial Geography and Ditching.

known as the glacial period, associated with the phenomena of these lake reservoirs, plainly extended much further down. The lowest points at which glacial gravel is observed in this Divide was below Forney's, about 5,000 feet above the sea; though at Bear Valley, near Emigrant Gap, on the C. P. R. R., a glacier reached down to 4,000 feet above the sea. At very numerously repeated points, within a range of 2,500 feet of altitude, and over an area extending twenty-five miles west of the summit, Nature has laid out, for the great mining region, and valleys of the foot-hills, and plains of California, a noble system of reservoirs, into which an abundant precipitation pours during months in the dryest summer when it never rains. How admirably the glacial valleys and lakes of the region are adapted to a doubled and quadrupled catchment, with trifling labor when the natural dams have been partially broken, can scarcely be realized by persons not familiar with these stupendous works (as they may be called) of design. From ten to twenty miles of ditching connects them with the region where gold has been concentrating for ages, both on and under the surface; and thence downward, upon the western slope, the vine flourishes, and the orange blooms.

Catchment Details

The number, character, and capacity of these reservoirs on Georgetown Divide, and the necessities, opportunities, and facilities connected with the water supply at the disposal of the California Water Company, are treated of in detail under Water, Subdivision V.

(b).—GEOGRAPHY.



Method and Map.

The geography of the Divide, as represented in the accompanying map, was obtained: at the western end, and as far as Gray Eagle Hill, by using the United States surveys, and locating in them the hills by solar compass bearings, triangulations, and by aneroid barometrical altitudes; toward the east end of the Divide, by road traverse chaining, solar compass bearings, and triangulations from the mountains thus located and connected.

Relief.

A great deal of detailed topography was obtained which I had not the time to plot.* The relief, as represented, therefore, is only such as was required for the purposes of this report; picturing approximately every principal feature of the country, as far as my opportunity would allow.

* With the plane table and camera lucida, by Capt. Daubissons' method, practiced in the topographical surveys of France.

Off the Divide.

The shore of Lake Tahoe was obtained from the United States surveys; and the Placerville road and its vicinity, across Johnson's Pass, from the Placerville and Virginia Railroad survey, of F. A. Bishop, made about twelve years ago. The neighborhood of Placerville was obtained from Bishop's ditch surveys. For useful material, both on the Placerville and Forest Hill Divides, so far as the map extends, I am indebted to Mr. L. A. Garnett.

Ditches.

The ditches of the Company and other local details connecting with fixed points, were obtained by pacing, with approximate or compass courses, and by "time trips," with compass or estimated courses.

(c).—THE MOUNTAINS.

SEVERAL SYSTEMS.

Grand Features.

This portion of the western slope of the Sierra Nevada does not differ materially from the characteristics of the range elsewhere. Situated nearly opposite, in the line of drainage of the mountain streams, to the outlet of Sacramento Valley through Carquinez Straits, the eastern end of the county lies in a region showing, in the summit culminations and lakes, more strikingly than any other in the range, the tendency of the Sierra Nevada to split into northerly and northwesterly trends of mountains, characteristic of the entire Pacific slope west of the Rocky Mountains. The northerly trends are peculiar to the great plateau of Nevada and Utah, which extends across into California as far as Mount Shasta, embracing the greater portion of Lassen and Siskiyou counties. (See axes of uplift, under Geology, Subdivision IV.)

SUMMITS.

At the point where Georgetown Divide joins the summit, there are three summit ranges.

1. Tell's Mountain range;
2. The main, or Western summit; and—
3. The Eastern summit, or Washoe range.

The two western are the highest, being nearly the same height. But the most westerly range carries the most snow. Its summer stores of the aqueous element are never exhausted. Between the snowy Tell's Mountain range and the summit runs the Rubicon River, a stream very large in midsummer and autumn, constituting the principal basin of drainage of the melting snows of late summer. The Snowy Summit

THE WESTERN SLOPE.

From a general altitude of 8,000 feet at its junction with the crest of the Sierra, Georgetown Divide (like every other divide of the range) sinks gradually and with great regularity, in fifty miles of horizontal distance, to an altitude of 175 feet at the margin of Sacramento Valley plain, near Folsom. Its Regularity

Being nearest to the outlet of the Valley (Carquinez Straits), the rivers of this portion of the Sierra are more deeply eroded, in proportion to the altitude of the range opposite, than elsewhere. Erosions in a Sloping Plateau

Independently of erosion, the slates of the Divide, which are generally bare of volcanic or detrital matter, have maintained a certain average outline of surface, about ten miles in width, between the two great cañons of the Middle and South Forks, remarkably regular on top, in consideration of the extent of the erosive action to which the country has been subjected.

Otter Creek, Pilot Creek, Little South Fork, and the Rubicon, on the north; Greenwood, Dutch, Rock, and Silver Creeks, on the south, are the principal lateral erosions. Yet they have scarcely been able to give a mountain character to the Divide beyond the immediate vicinity of the two great cañons that bound the Divide. One hundred and fifty square miles of undulating country, below 2,500 feet altitude, are only here and there intersected by an abrupt branch of the principal cañons.

Flats. And the country above Georgetown embraces many succeeding areas of fifty square miles in extent, comparatively flat, or diversified by knolls and ridges that seldom rise over 500 feet.

An Alpine Belt. East of Loon Lake Basin the Divide assumes an Alpine character. The surface changes from glacial *debris* overlying the slates to perfectly bare, polished, glaciated rocks. The forests reappear only in the higher and less glaciated summits, on ridges where the soil was not removed by the ice beds, on account of their higher altitude than the glacial levels; or in valleys, or moraine promontories of glacial detritus.

PARALLEL SWELLS.

Taking in the western slope at a glance, there are ten parallel swells or corrugations of uplift, to the west of, and, in general, parallel with the main summit, viz: beginning at the west:

1. The Pilot Hill trend of hills.

2. The Goat Mountain or Greenwood trend, consisting rather of a dome of country formed by numerous parallel mountain ridges or erosions extending from Brown's to Greenwood—in crossing it from west to east.

3. The Spanish Dry Diggings and Kelsey trend, in which are situated some of the principal mines; represented on the south side of the South Fork by the Quartz Hill range at Placerville.

4. The Hotchkiss Hill trend; another dome series of ridges or erosions, extending as far east as Works Ranch.

5. Tunnel Hill and Gray Eagle Hill trend.

6. The Sand Mountain trend.

7. Robb's Mountain trend.

8. Tell's Mountain trend, sometimes called the Conness Range, being a spur of the main summit from Pyramid Peak.

9. The main summit or water shed at Sugar Pine Pass. This is itself double, consisting of—

10. The McKinney range, just west of the McKinney (now Miller) Milk Ranch; and,

11. The Emerald Bay trend; the two joining in Captain Dick's Mountain.

12. East of Lake Tahoe is the eastern summit, or Washoe range.

TRANSVERSE RIDGES.

There is also a northeasterly and southwesterly trend of broken hills on this Divide, to which belong the Pilot Creek Reservoir range of hills, leading up into Robb's Mountain range and Slate Mountain. In the latter the strike of the slates is correspondingly altered to a northeasterly and southwesterly direction. To this system belong also the Peavine Hills.

(*d*).—EROSIONS.

The gorges of the Sierra measure, at mid-slope, 3,000 feet deep. At Forest Hill, the cañon of the Middle Extent

Fork is below the town 2,500 feet; below the top of the hill, 2,800 feet. At Deadwood, the cañon is 1,600 feet deep. At El Dorado Cañon, the river is 2,800 feet below the bluffs.

Angle.

The angle of slope in the latter cañon is nearly forty-five degrees. The upper edges of the walls are only three quarters of a mile apart. Probably the average angle of slope is not far from thirty degrees. The streams are mere gutters at the bottom, one or two hundred feet wide.

Titanus as a Quartz Miner

Under such conditions, when winter torrents rise to twenty, forty, and fifty feet above the usual level, flowing at the rate of six or eight miles per hour, carrying huge grinding rocks along with the water at the bottom, one can easily understand how these rivers were capable of executing the titanic work of erosion we still find them engaged upon—under the condition of free eroding grades varying between fifty and one hundred and seventy-five feet to the mile.

(e).—FOREST DISTRIBUTION AND CLIMATE.

There are four zones of forest distribution, which may be considered as corresponding to agricultural regions:

1. The Foothill Belt, west of Range 3, from Greenwood inclusive, to Pilot Hill, etc. It is twenty miles wide on Georgetown Divide. This belt is scantily covered with timber, chiefly black oak, frequently vast and spreading, with only scattering pines. Chemisal and manzanita cover many square miles, in thickets more or less dense.

Italian Zone

It is the Auburn and Smartsville zone. Very dry and

hot in summer, it produces plenty of grass in spring, or when irrigated, and is horticulturally highly favorably situated. Firs are rare; the vine flourishes, in some places (as at Brown's), even without irrigation; and peaches, apples, and other fruit are of the delicious flavor peculiar to the mountains. Almonds, walnuts, and oranges, in the lower altitudes, show in their growth and flavor every indication of congeniality of climate.

This region is semi-tropical or tropical—Italian in its climatic features.

2. THE LIGHTER TIMBER BELT of Georgetown, corresponding in situation to Nevada City. It lies, on this Divide, between the hill Ranges 3 and 5, from Greenwood to Grey Eagle Hill. Firs, yellow pine, and oaks, less spreading and taller than in the lower zone, beside a variety of other trees, occur. The soaproot grows in abundance in the airy and sunny woods Apple and other fruit trees flourish, after being once rooted, without irrigation. The vine does well in general, but delicate varieties occasionally suffer from frosts. Grasses last later in the summer. Snow, in the winter, seldom lies for many days at a time. Here, as well as on the lower zone, the situation, whether in a cañon or on a ridge, or of northerly, southerly, easterly or westerly exposure, makes a great difference in the character of the vegetation. Virginian Zone.

This region is semi-tropical or temperate—Virginian in its climatic features.

3. THE FOREST ZONE PROPER OF THE SIERRA NEVADA. Coniferous trees predominate. The luxuriance of these forests is unequaled in all the world. Each tree seems to express in its richness and individual perfection Hudsonian Region—Big Trees

something like a sentiment of delight in its own existence. It is the region of the Big Trees—between 3,500 and 6,000 feet in altitude. Cedars abound, beside the universal firs and pines; and numerous varieties of hardwood, some of which are tough and adapted to useful wooden manufactures.

This zone of vegetation, extending from the hill Range No. 5 to Range No. 7, covers a distance of about eighteen miles. Sugar pine (*Pinus Lambertina*) is plentiful. Wild plums and other berries exist. Manzanita is found only on exposed hill spurs, and chemisal brush on blasted slopes.

It is temperate, or Hudsonian—corresponding to Hudson River—in its principal climatic features.

4. The Summit Region Generally. It has the hardier firs and pines, which become brittle or stunted on the exposed or rocky ridges, yet continue to grow luxuriantly and of good quality, in groves and sheltered nooks, to an altitude of 8,000 feet.

Canadian. The sugar pine, yellow pine, and Scotch fir are the available lumbering material around Lake Tahoe. Wild gooseberries and raspberries are abundant. Alderbrush grows in the Alpine valleys, and white thorn brush on the exposed steep hillsides. The red snow plant shoots up like a column of fire out of the snow banks in spring. The earth is so suddenly blanketed by snow, in the fall, that it scarcely anywhere freezes. Grassy meadows around lakes of glacial origin continue green and luxuriant the summer through. Bunch grass is indigenous, on the westerly and southerly slopes, especially on moraine ground; but it has been killed off, to a large extent, by grazing sheep. Potatoes flourish

around Lake Tahoe. They are superior to any raised in the valleys of California.

This region is Canadian in its principal climatic features.

(f).—RAIN AND SNOW FALL.

The average annual rain fall at Georgetown, as observed by Mr. McKusick, is forty to forty-seven inches. At Georgia Slide, a little further north, the same results have been obtained. At Placerville, the result, as measured by gauge, is an inch or two less. The total precipitation at Georgetown for the last season, as measured by Mr. McKusick, was forty-seven inches.

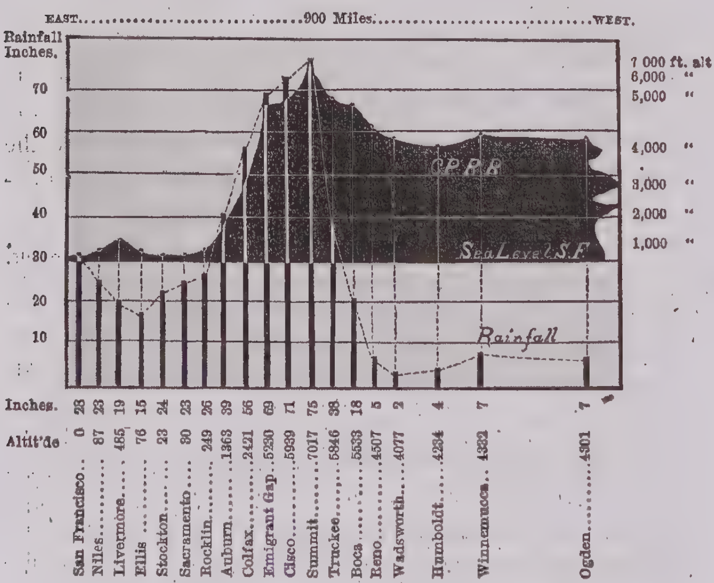


Fig. 3--PACIFIC SLOPE RAIN SECTION.

Showing the Rainfall in the Interior as compared with that at the Sea Coast; and also as affected by altitudes. For the rainy season from Aug. 1, 1871, to May 1, 1872.

The Mountains and the Sea.

The accompanying rain section, based upon careful gauge observations (Fig. 3), shows the prominent characteristics of precipitation along the line of the ditches of the California Water Company, in comparison with the rainfall at sea level at San Francisco, and on the western slope of the continent generally, from the Pacific Ocean to Salt Lake.

Systematic Observat'ns

It is constructed for your information from measurements, made in 1871, under the direction of S. S. Montague, chief engineer of the Central Pacific Railroad, at the several stations named. Those stations, situated on the western slope of the Sierra Nevada, are so near to Georgetown Divide that the measurements are the same as they would be if they had been actually made along the line of your ditches.

Relief and Rainfall.

The remarkable correspondence to the relief of the continent, and the precise manner in which the rainfall is affected by altitudes, as well as by proximity to the sea, or to sea level, are graphically shown in an easterly and westerly direction, or cross section.

NORTH AND SOUTH, OR LONGITUDINAL VALLEY RAIN SECTION.

Dry Places in Valleys.

The fundamental conditions of demand for reserved water, in the great valley opposite the Georgetown Divide, are graphically represented in the accompanying north and south section, Fig. 4.

A curious departure from the strict rule of altitudes, as affecting the rainfall, is observable in the longitudinal valleys. While the rainfall at Sacramento, opposite Georgetown Divide, increases over that at sea level near Suisun Bay, or Stockton, correspondingly with the altitude as represented, that of San Joaquin Valley decreases materially, notwithstanding the increased altitude. Adjacent mountain ranges or timber belts are probably the cause.

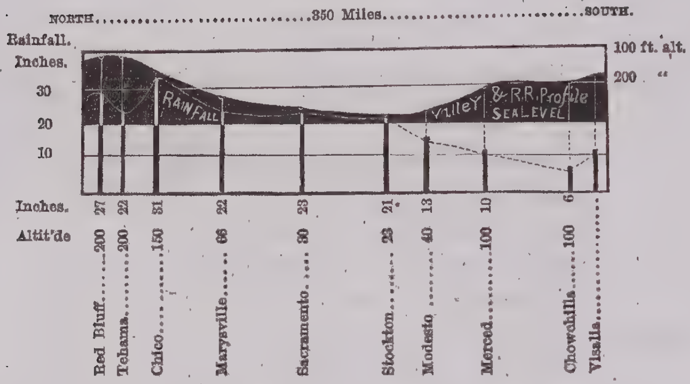


Fig. 4--CALIFORNIA VALLEY RAIN SECTION,
Along the line of the Oregon and San Joaquin Valley Railroads.

(*g*).—SEASONS.

THE RAINLESS SUMMER.

From May to August there is no rainfall worth mentioning, or capable of measurement, on the western slope of the Sierra—nothing beyond a sprinkling. *Limits of Dry Season*

The dry season of the year in the Sierra is at its height in August and September. Until the end of September the water in Pilot Creek and Little South Fork basins grows less and less. By the first of October, however, it commences to increase again from the new rainfall.

THE SEASON OF RAINS

In the lower zone is, as stated, from November to May. It corresponds to what, in the higher zones, is a similar season of very heavy and continuous rains. *Mountain Floods,*

The streams in the cañons then become terrific. The suddenness of the mountain floods is such that the

water rises in the narrow cañons in a few days from twenty to thirty feet.

Spring and autumn become definite seasons only in the high Sierra.

(*h*).—RAIN ZONES.

ACCORDING TO THE BEHAVIOR OF SNOW.

No Snow. The rain zones on the flanks of the Sierra correspond to the forest zones. The foothill belt shares the climate of Sacramento Valley, which also grows spreading oak. Snow *never falls*, or only as a nine years' wonder. No rain falls between May and November.

Snow all Winter. The light forest zone has rain later in the summer—a shorter dry season. Snow lies, in winter, for several days at a time. The heavy forest zone has snow lying *all winter through*. The summit zone, *per contra*, has

Snow all Summer. snow lying *all through summer* on the higher points, or even lower down; and so late into the summer as to stunt vegetation which is not favorably situated as to soil and sunshine.

WATER STORED AS SNOW.

Rationale of Snow Line. There has never been a time, except in the last three or four years, when there has not been old snow lying in Loon Lake Basin the summer through. Even in Pilot Creek Basin, at the head of Pilot Creek ditch, there "has always been snow in summer heretofore," as I am informed. During recent years the snow fall has been light, and it has not accumulated. When the snow fall is heavy, the snow keeps on accumulating until there are heavy banks, and the same snow continues to lie for a series of years.

Valley Floods. The present winter being one of heavy snows, and

low temperature, banks will probably form, and again accumulate for a series of years. Floods in the great valley are owing, therefore, to the high temperature accompanying precipitation as much as to the rainfall of the season itself. Snow at the summit lies from ten to forty feet deep.

Light summer showers, accompanied by thunder, are characteristic of this region. Thunder.

(i)—WINDS.

The winds are ordinarily from the valley in the daytime, and from the mountains at night. The foothill zone, like the valley of the Sacramento, is subject in summer to parching, often scorching, north winds. In the heavy timber zone, winter blasts from the east are sometimes very strong. In the summit zone, summer thunder storms, accompanied by light rains, come from the north; while the ordinary daily winds are, as in the lower altitudes, westerly and southwesterly breezes. Northerly Southwesterly

(j)—TEMPERATURE.

In the foothill zone the ice *barely freezes on winter nights.* In summer the thermometer keeps near one hundred degrees for many hours in the day. In the summit region, *per contra, the ice freezes* at Ward's Valley, opposite Lake Tahoe, *on midsummer nights.* Ice

At Georgetown, near mid-slope (altitude twenty-five hundred feet), the thermometer has been observed by Mr. McKusick for several years—the result showing an average, from readings taken at 9 A. M. and 3 P. M. in *winter*, of fifty degrees to sixty-five degrees, sometimes down as low as forty, but not often; in *summer*, at the same hours, from seventy-eight to ninety degrees; occa- Thermometer.

sionally as high as one hundred and two degrees, which is the highest.

The extremes for the month of December, 1873, were from thirty-one degrees to sixty degrees; for the month of June, 1873, from thirty-three degrees to ninety degrees.

THE BAROMETER

An inch to 1000 feet

Stands, at Georgetown, at twenty-seven inches in summer, and 0.1 inch higher in winter, indicating an atmospheric pressure of three inches of the mercurial column less than at the sea level, being twenty-five hundred feet above the sea. An inch is, at this height, about equal to one thousand feet.

For EVAPORATION, see under "Water," subdivision V. The hygrometer has not been observed.

(*k*)—DISCHARGE OF RIVERS

AT THE HEIGHT OF THE DRY SEASON.

7600 inches

The discharge of waters from the basin of the American, as gauged at Folsom, at the lowest stage in summer,* in 1866, was 12,691 cubic feet per minute.

AT EXTREME FLOOD.

Leet & Goddard's rep't

Measurements were taken of the sectional area of the American at Folsom Cañon, Brighton, and Sacramento, under the auspices of the Trustees of Swamp Land District No. 2 (Sacramento county), during the great flood of January 9 and 10, 1862. The results were published in the "Sacramento Union" of May 6, 16, and 19, 1862; but the figures (in cubic feet per second) are so extravagantly large (nine hundred times the discharge of the

* Carefully measured at extreme low water, in 1866, by H. F. Knight, Superintendent of the Natoma Water Company.

Mississippi) and the actual measurements are so obscurely stated, that I shall quote neither. The sectional area of the flood waters at Folsom Cañon was about two hundred feet wide by forty feet deep, as reported by Watson, engineer of Sacramento Valley Railroad, which, allowing for shelving bottom, would be equal to a sectional area of half of two hundred by forty, or four thousand square feet; and the velocity, though set down by Leet and Goddard at thirty-one miles an hour (a rapid train movement), could not have exceeded, probably, an average of ten miles an hour, or eight hundred and eighty feet per minute, which would make the discharge three and one half million cubic feet per minute, or nearly three hundred times the quantity discharged at the lowest stage in summer. 2 million inches

AT THE ORDINARY FLOOD SEASON

Each winter varies. Estimating the ordinary discharge of the last winter at four hundred and seventy-five thousand cubic feet per minute, this would still be thirty-six times the quantity of water discharged in summer.

In other words, the ordinary discharge of rivers and streams, in this region, is at least thirty times, and the extraordinary, three hundred times greater in the saturated months than in the three or four parched ones, which are to be taken into consideration in the principal operations of a Water Company 30 to 300 times that of summer

TOTAL PRECIPITATION.

Taking an average of the seventy, sixty, fifty, and forty inches of rainfall, at various points on the Divide, or western slope of the Sierra, at *fifty-five* inches, or four and one half feet, and the area of the Divide at one thousand square miles, the total rainfall would make 4½ feet of water falling

Lake 18 feet deep — a lake of two hundred and fifty square miles, or twelve miles by twenty-one miles, eighteen feet deep.

1 acre in 4 — Every *four acres* of valley basin would fill a reservoir of *one acre* to the same depth; equal to seven hundred and eighty-four thousand cubic feet, or a stream of ten miners' inches, running ten hours a day (enough to irrigate four acres of alfalfa), for over two and one half months.

1 acre catchment to 1 acre alfalfa — In other words, *one acre of catchment* would irrigate *one acre of alfalfa* for two and one half months, with a constant flowing stream of two and one half miners' inches. Evaporation and seepage could scarcely curtail this stream to two months.

Conclusion — From these climatic data, which may be depended upon, it will appear evident that it is not the water so much as the facility and economy of impounding it within reach of where it is wanted in the rainless season, that have to be looked to in the operations of a water company in California.

III.--MINING.

UNDER this head will be considered, in the order of their geographical position, the characteristics of individual mines. Their general relations will be considered under Geology, Subdivision IV.

(1).—MINES OWNED BY THE CALIFORNIA WATER COMPANY.

The mining properties owned, in whole or in part, by the California Water Company, more particularly described further on, are:

1. The French, or Nagler claims, Greenwood; comprising three claims, viz: The French claim proper, the St. Lawrence, and the Fenton. A one-half interest.
2. The American, or Smith mine, north of Green-Wood. A half interest.
3. Ground near the American. The whole.
4. The French Hill claim, Spanish Dry Diggings. The whole.
5. The Grit claim, Spanish Dry Diggings. One quarter.
6. The Whiteside mine, Crane's Gulch. One half.
7. The Blazing Star, Wentworth & Co., near Kelsey's. One half.

8. Ground adjoining Wentworth's, fifteen hundred feet on the seam belt. The whole.

9. Bed Rock Sluice, Greenwood Cañon, three fourths of a mile long. One half.

10. Kelsey Cañon to the South Fork of the American, a distance of 3,000 feet. The whole.

11. Schlein's Diggings (placer), Tipton Hill. The whole.

12. Lease of the Ross claim (placer), near Volcanoville, to run two years.

13. A Prospect Quartz claim, near Johntown. One eighth.

14. Bunker Hill (copper mine). The whole.

15. The Bowlder Hill (placer). The northern extremity of, including a tunnel to work the same.

(2).—YIELD OF GOLD MINES.

Averaging impracticable.

The following statements were made to me by various parties not interested, and subsequently scrutinized or pruned down to what may be taken as generally accepted figures.

25 cents.

(*a*) Of the Seam Diggings—Pan Assays.—In mines of a character so irregular as the seam, pocket, and the lense-shaped quartz mines of this region, no average yield can be arrived at or stated. Even the absolute yield in particular cases during a limited period is difficult to obtain. No "run" is like another.

When seam diggings are prospected, the report is so many "cents to the pan."

(1).—AT SPANISH DRY DIGGINGS.

Strikes.

Drift mining, often during one month, pays so well,

I was informed, as to answer for fruitless work during the remainder of the year. Mr. Davis, a practical miner at Spanish Dry Diggings, summed up the philosophy of seam mining by remarking, "that the country hereabouts is splendid for poor men to prospect; but none of them have ever learned when to stop. Everybody here might have been rich."

THE GRIT CLAIM.—Captain Swift, of Georgetown, owned and worked in the Grit Claim for seven years prior to 1867. He reports that they got out one hundred thousand dollars during that time. The principal gold was taken out in 1852. Mr. Waun, of Spanish Dry Diggings, estimates that they took out of the Grit Claim, altogether, about three hundred thousand dollars. $300,000.

THE TAYLOR & RICE MINE, at the same place, paid Mr. Taylor about twenty thousand dollars. They took out altogether about sixty thousand dollars. $20,000.

THE FRENCH HILL CLAIM paid within the space of a few feet square (at *a* in the section below) three thousand dollars. $3,000

THE BARR & CROSSTON MINE.—Messrs. Barr & Crosston went out of the country with seventy-five thousand dollars, which was cleared out of their mine. Upon one occasion they brought up the hill sixty-five pounds and eleven ounces of gold, the product of a month's labor. $75,000—65 lbs

(2).—AT GEORGIA SLIDE.

THE PARSON'S CLAIM has been worked successively for twelve years, and now pays, according to one of the proprietors, seven hundred dollars per month clear of Seam Mining Profitable

all expenses to three men employed. They have taken out as much as eighteen or nineteen hundred dollars a month, clear of all expenses. The latter amounted to one hundred dollars per month for powder, fuse, etc., and a dollar and fifty cents a day for ten inches of water, at a bit an inch a day (twenty-four hours), the company having a small ditch of their own. Probably half a million dollars have come out of Georgia Slide.

$500,000.

$8,000 Per Month.

THE BEATTY CLAIM yielded, according to Mr. Barklage, one thousand dollars in one month, clear of all expenses, to a one-eighth interest; making a total of eight thousand dollars per month clear of all expenses. It has been worked and constantly paying for seventeen years, but at what rate is unknown.

(3).—AT GREENWOOD.

$100,000.

THE FRENCH CLAIM, at Greenwood, has paid from twenty thousand to thirty thousand dollars to the Water Company alone. The rate has been as high as one hundred and twenty dollars a week, but the average would probably be about eighty dollars a week, running two thirds of the time. The total yield, from the best information obtained, is about one hundred thousand dollars.

$23,000.

THE ST. LAWRENCE, THE MCMICHAEL, AND FRENCH CLAIMS, at Greenwood, were each yielding, in 1860, at the rate of forty to fifty ounces per week. The St. Lawrence has yielded a total of twenty-three thousand dollars. The outlay for water was eight thousand dollars. Four men were working in it for ten months, with the above result.

$13,600.

THE SPANISH CLAIM has yielded eight hundred

ounces, worth seventeen dollars per ounce, equal to thirteen thousand six hundred dollars.

(4.)—EMPIRE AND MANHATTAN CANON RIDGE.

THE CRANE'S GULCH MINE has yielded about one hundred thousand dollars. $100,000

(4)—ON THE PLACERVILLE DIVIDE.

THE "PORPHYRY" LEDGE, worked by Fisk and others, has paid very large sums. In 1870, four parties were at work. Fisk, in that year, took three thousand dollars out of a space eight feet wide, ten feet deep, and twenty feet long, and four hundred dollars in a day. Hodge took out considerable dirt containing one hundred dollars to the pan. Detached pieces weighed from twenty-five to forty ounces. $3,000.

Placerville Divide, in 1870, shipped gold from its seam and gravel mines at the rate of ten thousand dollars per week. $10,000 per Week.

(b).—YIELD OF QUARTZ MINES

THE ST. LAWRENCE ships its bullion very regularly. Its average rock pays twenty-five dollars a ton; picked rock, fifty dollars a ton. The St. Lawrence was purchased, in 1871, by the present owners, for fifteen thousand dollars. At that time it had been crushing rock for a while worth fifteen dollars a ton. There are forty stamps in the mill crushing forty tons of rock a day. $25 Per Ton

THE WOODSIDE MINE yielded from twenty to thirty thousand dollars and upward. $30,000.

THE CLIPPER MINE has yielded about eight thousand dollars. $8,000.

$2,500. THE KEEFER MINE yielded two or three thousaud dollars.

$45 Per Ton. THE CEDARBERG.—The average assay of the Cedarberg rock, according to the superintendent (Mr. Halforth), at the time of my visit, was from forty-five to sixty-two dollars a ton. Out of a space twenty-five feet $45,000. in depth, twelve feet long, and about eight feet wide, near the surface—ninety cubic yards—forty-five thousand dollars were taken.

(c).—YIELD OF PLACER MINES.

Ten Cents Per Yard. ON THE MOUNT GREGORY RIDGE there are nuggets of coarse gold, mixed with fine gold in scales. The gravel is said to pay, in many places, ten cents per cubic yard. Nearly every pan of dirt, in some of these mines, shows colors of gold.

$50,000. OREGON HILL.—Several years ago Jones & Company realized out of mining operations in Oregon Hill, fifty thousand dollars. In 1870, they were reputed to be making two thousand dollars per week.

$25,000. THE BOWLDER CLAIM cleaned up twenty-five thousand dollars from seven months' run.

$500,000. JONES' HILL, according to S. Bently, of that place, has yielded, from its ancient river and seam diggings together, over a million dollars. This figure is not discredited by Mr. Barklage, merchant and dealer in gold dust at Georgia Slide. Mr. McKusick thinks Jones' Hill gravel mines have yielded as much as half a million dollars, safely.

5 Millions. AT COON HILL, on the Placerville Divide, twenty-five acres of gravel yielded, according to Bishop's calcula-

tion, based on actual returns, twenty-five million dollars. These figures seem rather large. To be on the safe side, say five millions.

(3)—CHARACTERISTICS OF MINING.

Beginning with what would appear to be the older strata at the west (see under IV):

(1)—OPHIR DISTRICT.

GEOLOGICAL CHARACTERISTICS.—The mines of this district are all near the line of junction between the slates and the foothill granites, bordering Sacramento Valley. The best paying mines, according to the popular impression, are situated near the line of contact. The Ophir and Bellevue veins are both in granite; the St. Patrick and the Green in slate. Contact of Slate and Granite

The line of contact has the same course in general as the strike of the slates. Auburn is in slate. The junction occurs very nearly (not quite) halfway between Auburn and the Ophir mine. Further down the mountain slope the country is of granite, as far as there is any rock visible, to Sacramento Valley

Both the granite and slate, in this region, are very hard at one hundred feet depth. On the surface, they have, in some places, weathered soft to the depth of twenty feet.

VEINS.—The veins, or seams, in the district, all have the same course, parallel to the strike of the slates—north-northwest and south-southeast. The quartz and vein material generally, including the ore, is pockety in character, resembling, in that respect, all the pay mines described as worked in Georgetown and Placerville Divides. Lenticular masses continue for some dis- Lense Shaped Quartz

tance, and then pinch out. There is always a fissure, however, that continues, leaving no doubt that they are true fissure veins. The quartz is from six inches to four feet wide.

THE PAY is in the form of flakes and sheets. Most of the ledges are impregnated with sulphurets of iron, which assay never less than a few dollars to the ton. The country rock adjacent is always considerably impregnated with sulphurets.

$200 a Ton

THE YIELD varies very greatly In the case of a replevin suit, attended by Cravens, the State Librarian, thirty sacks of ore out of the Ophir mine contained twenty-three hundred dollars. A good deal of the rock is worth several hundred dollars to the ton. A rich pocket was struck in the seam mine, however, "which was almost all gold." With a hand mortar a man might frequently make fifty dollars a day out of the vein material.

200 Feet.

EXTENT OF MINING.—On the Bellevue vein they have gone down two hundred and fifty feet, or deeper; in the St. Patrick and Green, about the same depth. The Ophir works have reached a depth of about two hundred feet.

(2).—PILOT HILL.

"Coyoteying."

On the easterly slope of Pilot Hill there is a belt of seam diggings resembling those of Greenwood, which have been worked to considerable extent by coyoteying shafts and levels, and arastra milling in true Spanish style. The ground has been surfaced off over forty yards square. They were not worked during the time of my visit, but were reported to have yielded good pay, and to be excellent property.

(3) —NEIGHBORHOOD OF GREENWOOD.

Beginning at the north and going southward along the strike of the slates: On the top of the hill west of Greenwood there is, first, the—

(1). SPANISH MINE.—This shows the usual characteristics of parallelism to the slates, the vein standing nearly vertical, and being intersected by minor cross seams.

There are two principal pay seams, running northerly and southerly, and embracing a seam-belt about one hundred feet wide. All the smaller seams and side stringers carry gold. A space of four hundred feet by twenty-four feet, and four feet in depth, has been hydrauliced off, yielding thirteen thousand six hundred dollars. The pay has been followed farther down in a shaft eighty feet deep, and explored in tunnels and drifts for twenty or thirty feet in either direction. The vein at the bottom of the shaft is two and one half feet wide. The dip of the eastern vein worked appears to be toward the southwest 50°, but there are indications elsewhere of conformity of dip with the general dip of the country rock. Vein and seam belt

From a cut about seventy-five feet distant, west from the principal shaft, there is a drift running north thirty-five feet, and another south fifty feet, on a ledge three feet thick, parallel to the above mentioned.

(2). THE CARROLL CLAIM is on the east slope of Greenwood Hill. A space eighty by forty feet, and fifteen feet in depth, has been hydrauliced away, and a tunnel has been run in, at a lower level, to intersect the seam-belt, which is at the west end of the hydraulic pit. There are three series of *cleavage courses* lined with auriferous decomposed quartz, dipping respectively Cleavage courses

north 20° east 50°; south 45° east 30°; and north 65° west 70°; the latter being often double, as represented in the diagram, Fig. 5:

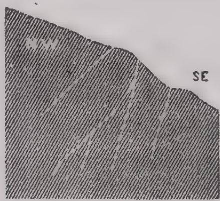


Fig. 5.—CLEAVAGE IN CARROLL MINE.

Quartz seams.

The southerly and southeasterly dips are regular and uniform. The latter have flakes of quartz, which are probed out by the miners. In the line of the southeasterly dip there is a very hard, blue, metamorphic trap, of the character common to the country, intercalated between the cleavage lines. It appears to be a mass by itself, and but for the frequent repetition elsewhere of similar masses, that are undoubtedly metamorphic (changed from the slates), it might be mistaken for eruptive trap.

Metamorphic trap.

Quartz ledge.

About one hundred and fifty feet west of the intersection of the pay seams, there is, on the top of the hill, one hundred feet higher, a well-marked quartz ledge, which carries a single, solid seam, four inches in thickness, either belonging, or closely related, to the same metalliferous channel.

Tunnel.

The tunnel mentioned was run in by LeDuc, at a point two hundred feet east-northeast and ninety feet below the pit; in a west-southwesterly course, distance unknown. Less decomposed specimens of the rock than those on the surface are here met with.

Pay.

THE PAY is in a soft, red dirt, intermixed with a partially-decomposed, "scraggly" quartz, occupying the

position of quartz veinlets. The decomposed quartz containing gold is, to a large extent, clayey red, ferruginous dirt, which would catch gold in it and carry it through the sluices.

On panning out a quantity of the pay dirt, which had been pointed out as such by Mr. Carroll to Mr. Jones, we were not rewarded with a color.

A sectional view along the tunnel through the vein-belt discloses the following features:

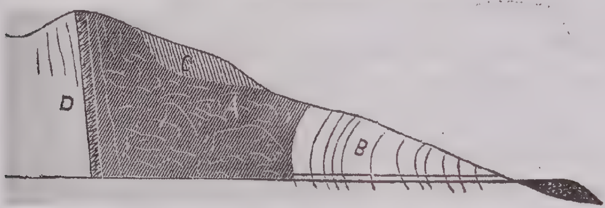


Fig. 6.—CARROLL MINE, GREENWOOD HILL.

A—Belt of metamorphic decomposition.
B—Perfectly laminated black slate.
C—Carroll claim.
D—Quartz vein.

(3).—THE FRENCH, OR NAGLER CLAIM.

This is worked in a vein system in the strike of the slates; course, south 37° east; dip, northeast 75°. The width of the seam-belt here is about two hundred feet. On the west side of the principal vein lies one hundred feet of *typical porphyry*, strikingly different in color and mineralogical constituents from the rest; and on the east side, decomposed slate rock, lithologically probably much the same as the "porphyry." Vein, porphyry.

There are found isolated portions of the same porphyry in different stages of consolidation, from hard, blue diorite, through all stages of hardness to red and brown loam. Stages of metamorphism.

An area of about two thousand square yards is hy- Pit and product.

drauliced off to an average depth of about thirty feet. Gross yield of mining operations about one hundred thousand dollars.

Vein section

The *main vein* is four feet wide, and constituted of decomposed quartz and gouge. Along it is laid the sluice. Looking south along this I observed the following section:

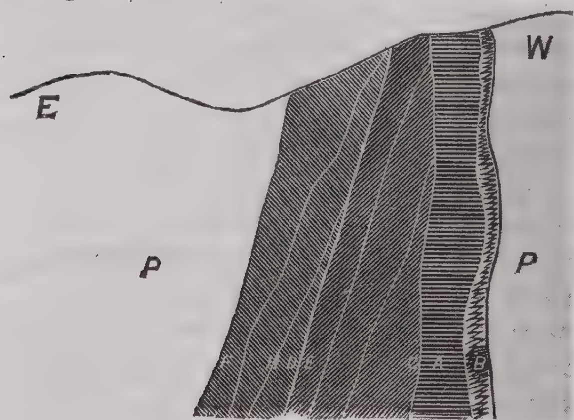


Fig. 7.—SECTION OF NAGLER VEIN.

PP—Porphyry in part; metamorphic belt in the slates.
A—Main vein of dark colored matter, resembling gouge.
B—Quartz seamlets.
C—Well defined vein wall.
F to E—More or less perfect wall parallels, possibly due to stratification, enclosing in *F E C* white and yellow specimens, accompanying report.
D—Zone of white and yellow, stratified.
E—Perfect wall, with smooth sides.
F—Perfect wall, with smooth sides.
H—Zone like *D*.
CE—Zone containing porphyritic trap masses.

The main vein is shaded dark. The best marked fissure wall is *C*. A series of slate-like strata, six feet wide, of probably pseudo-morphic stratification, are seen in the hanging wall, separated from the accompanying porphyry country rock by another well marked fissure wall (*D*.) The dip of these two fissure walls men-

tioned is such that they must meet near the soil at the surface of the ground where the Georgetown and Greenwood road passes around the head of the claim. *D* evidently joins the main vein again under foot. Very little quartz is found in the main vein.

A Cross Vein, of solid quartz, running at right angles to the former, starts east from the middle of the claim, and bends around to the southward. It is probably one of the same system of intersecting veins, the course and dip of which are observed repeated in the Fenton and St. Lawrence mines; at this point intersecting the main French claim vein itself, and enriching it to the extent of a considerable portion of the yield of the French claim. A shaft has been sunk on this, twenty-four feet deep, at a point forty feet from the main vein, to a depth of thirty feet. It has proven not only the continuance of a considerable vein of quartz, two feet wide at the bottom, not counting the stringers, but of a chimney of good pay, the working of which had been drowned out at the time of my visit. The course of this vein is north 68° east for the first forty feet from the vein; thence it is followed by a tunnel, twenty-six feet in length, running south 85° east. The dip alters in that distance. Starting out at 70° toward the south, it is as steep as 80° or 90° near the surface on the east face of the bank of the claim; while in the tunnel, twenty-six feet into the bank, its dip is, on the level of the sluice, 80° toward the south. The dip of the vein at the bottom of the shaft is the same as at its mouth at the tunnel. Hence it is a twisting cross vein, at the point where it runs into the main vein; and its true or general course can be better judged by identifying it with other cross veins of the same system, found, as stated, at a greater distance.

Enrichment by junction

Course

Cut-off.

This intersecting vein does not cross the main vein. It is cut off by the strongly-marked porphyry to the west on the foot wall of the main vein. Though strongly developed on the one side, not a sign of the vein can be found, apparently, on the other.

Standing on the main, and looking east, the cross vein presents the following sectional view:

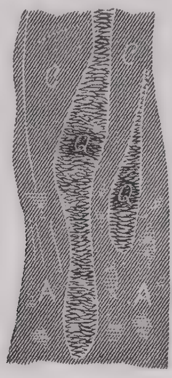
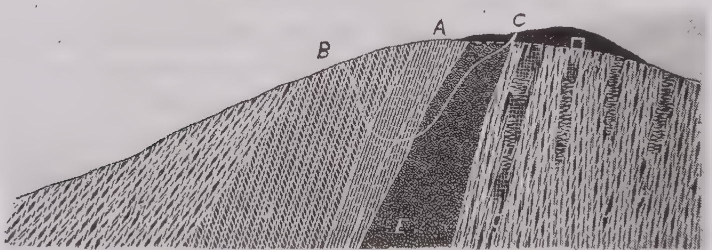


Fig. 8—CROSS VEIN, NAGLER CLAIM, GREENWOOD.

C—Clayey vein deposit.
Q—Quartz.
A—Irregular continuations of clayey deposit, mixed with scragly quartz.

RELATIONS TO COUNTRY ROCK.

A section across the French or Nagler claim seam-belt, as a whole, presents the following characteristics:



A—Main vein.
B C—Sectional outline of pit.

D—One hundred and fifty feet of hard blue and also decomposed red and yellow porphyry, occasionally showing evidences of stratification related to that of *F*. In the Curtiss mine, adjoining the French claim on the north, it becomes evident to the eye at a glance that this is but a metamorphosed concretionary form of the slates. Near the junction of the Curtiss and Nagler claims, it becomes evident, also, that the white pyritiferous rock of the Carroll claim, and the "blue porphyry," or diorite, are the same rock in varying forms. They are due, I think, to nests of metamphorphism. Metamorphic porphyry

E—Soft feldspathic porphyry, worked ninety feet west of the sluices, without any signs of stratification whatever. Quartz veinlets run in this fifty or seventy feet from the main vein, one series of which has a dip and strike corresponding to that of the main vein.

F—Slates, perfectly formed, like those at the Carroll claim, dip, north 40° east 40°, getting steeper toward *D*.

G—Slates two hundred and thirty feet; intercalated with quartz and trap dikes near the top of the hill, along the Greenwood road.

H—Quartz ledge, dipping slightly to the east again.

J—Exposed ledge, containing nodules and lenses of quartz; vertical, or of a slightly westerly dip

K—Tunnel on south side of road, near the flume over the road.

(4).—THE FENTON MINE.

Shows a decomposed belt, to the west of which is a belt of hard, green porphyretic trap or green stone, the non-denudation of which caused the several hills back of Greenwood, situated between the French claim and the Fenton mine. Soft and hard belts

A space of forty by sixty feet is hydrauliced off to an average depth of six feet.

Two vein systems.

Two sets of quartz veins are visible beside the main pay channel, as forming the skeleton of the seams of this mine; the one having a course north 70° east, and dipping 80° south; the other having a strike north 70° east, and dipping south-southwest 50°. The vein is locally dislocated. On the one side of the ravine it is shoved down hill ten feet, and there dips east 75°.

Tunnel.

From a point nearly opposite the angle of the Georgetown road with Greenwood Valley, at Nagler's store, two hundred feet from the mouth of the sluices, a tunnel has been run in a distance of three hundred feet without intersecting the seam belt.

(5)—THE ST. LAWRENCE SEAM MINE.

Favorable to hydraulicing.

MINING.—Here an immense hole has been washed out in unusually soft ground, with one hundred inches of water, at a cost of ten or twelve dollars a day. Ten months' time did the work. There was paid for this water only eight thousand dollars. Four men were employed, and the yield was twenty-three thousand dollars.

Quartz vein as foot wall of the seam series

GEOLOGICAL FEATURES.—The hill to the west of the mine, a continuation of Greenwood range (already referred to as having been left undenuded on account of its hard character), is at this point not constituted of greenstone porphyry entire, but of slates, in part unaltered, in part considerably metamorphosed, and only assuming the form of greenstone porphyry in nests. The local cause of the existence of this hill makes itself prominently known to the eye in the form of a great longitudinal quartz vein which is situated at the apex.

It is in the strike of the slates, and forms the west or foot wall of the seam series. *The entire hill-top is covered with quartz croppings.* This ledge, associated with greenstone porphyry, forms cones all along the range to its termination at the south, where Greenwood Creek cuts through the Greenwood range of hills, three quarters of a mile south of Greenwood village, crossing Greenwood Cañon in a plainly-traceable decomposed belt, and in several parallel vein-belts. (See section across Greenwood Hill, further on.)

The continuation of the Greenwood belt toward the south is marked by mining operations in the hill on the west side of Coloma Cañon, near mid-slope toward the cañon, bearing from Greenwood Hill south, 42° east.

St. Lawrence main vein

About the middle of the St. Lawrence mine there is a vein which is considered by Mr. Nagler, one of the owners, to be the same as the main vein in the French claim. It is about eighteen inches wide, and has a very perfect foot wall. A shaft was sunk down along this thirty-eight feet deep, in solid slate. Mr. Nagler says he has traced this vein over the hill all the way to the French claim. From the main vein of the St. Lawrence another series of seams run off, striking to the south-east.

Intersecting seams.

Seam-belt.

The seam-belt is on the east or hanging wall, in this case, and is about one hundred and twenty-five feet in width. Mr. Nagler thinks that as they go down on the seams the rock changes into solid slate.

The following section exhibits the principal features of the Greenwood seam-belt at this point, in association with some local disturbances of the slates:

W. S. W. ....150 yards........................E. N. E.

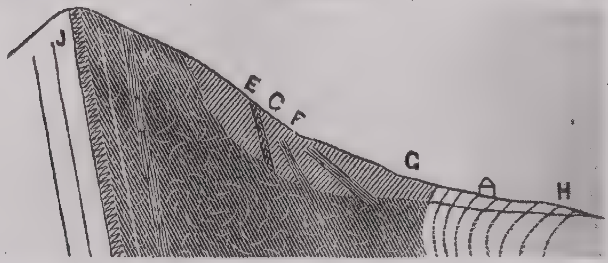


Fig. 10.—SECTION OF ST. LAWRENCE SEAM MINE.

E—Red stratum, 3 feet, in position of main vein (which was covered up by a slide).
F—Red and white, dipping NE 35°.
G—White.
H—Slates dipping W 50 to 80°.
J—Quartz vein, accompanied by trap masses and metamorphosed slates, all dipping ENE 70°.
G to E—Pit of St. Lawrence mine.

The pay is mostly found near the vein, not in it; in the hanging wall, or on the east side.

SECTION OF EROSION THROUGH THE GREENWOOD SEAM-BELT AND THE GREENWOOD RANGE OF HILLS.

The seam-belt 150 feet deeper.

Descending along the quartz and porphyry comb at the south end of the St. Lawrence Hill, I found, a few yards below the junction of Greenwood and Coloma cañons, opposite Chinatown, not only the decomposed belt of the Greenwood mines in the bottom of the valley, one hundred and fifty feet lower than the bottom of the French claim, but several distinct sets of quartz veins or seams, as represented in the following section:

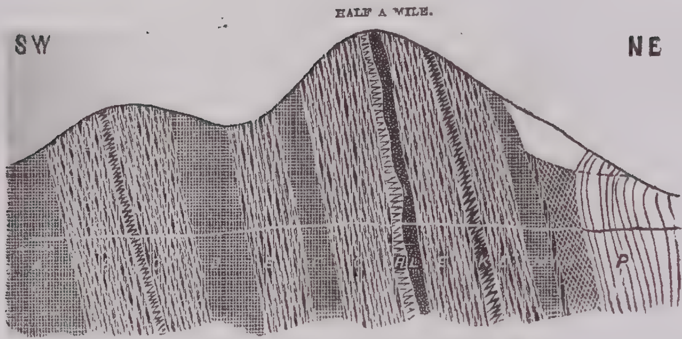


Fig. 11.—SECTION ACROSS GREENWOOD RANGE OF HILLS AT GREENWOOD CANON, NEAR CHINATOWN.

A—Metamorphic trap (aphanite.)
B—Soft decomposed slate rock.
B C—Petro's quartz ledge, 18°.
C—Decomposed slate.
D—Metamorphic trap, 160 yds.
E—Hard, dark colored slate, 60 yds.
F—Metamorphic trap, 25 yds.
G—Slates, dark, hard, and perfectly laminated.
H—Mass of silicified strata, 16 ft. (with a few quartz seams); not continuing as such along the strike across the bed of the creek; cropping out in ledges on the hill N. 20 W., striking direct for the top of St. Lawrence seam belt. This point is 100 yards southwest of the ledges *K*, and 200 yards west of Chinatown, on the old Georgetown road.
I—Conglomerate bed, 3 feet.
E—Slates, perfectly laminated.
K—Quartz ledges, striking N. 25° W.; nearly solid, about 4 feet wide, standing almost vertical. There are two principal stringers of quartz, the heaviest being on the west side. That on the east is more earthy, consisting of a number of parallel seams. Between the two there is a black seam, 3 inches thick. To the westward of the series is a great number of small quartz seams going off into the country rock.
EE—Slates, occasionally silicious.
M—Belt of iron-colored weathered greenstone (aphanite), 100 feet.
N—Slate, 20 feet.
J—Light colored decomposed rock, 125 feet, corresponding to the position of the St. Lawrence mine; 75 yards from the old Georgetown road.
P—Perfectly laminated dark slate.

(5).—EAST SLOPE OF COLOMA CANON.

Leaderick & Co. have here a shaft down twenty-two feet upon a quartz ledge, two feet in width, carrying gold. From two hundred and fifty pounds of rock there were pounded out seven ounces of gold.

(6).—RICH FLAT.

Southward in the same strike of the slates.

The Blazing Star mine (Wentworth & Co.) is situated about two miles west of Kelsey's, by the road. Rich Flat, one and one half miles west of Kelsey's, is supposed to be on the same range; the strike of which, in the line of the slates, would locate the continuation of this zone one half or three quarters of a mile west of Placerville.

$100,000.

At Rich Flat, common report says there have been taken out one hundred thousand dollars from surface diggings in the main.

$3,000.

At Wentworth's Andre Bullion took out three or four thousand dollars. The vein is in all respects similar to that of the French or Nagler claim, Greenwood. It stands very nearly vertical, is composed of a principal line of fissure and associated metamorphism, and has, on the east, over one hundred feet of soft slate, or porphyry, which is being hydrauliced into the creek, running from this point south into the South Fork of the American.

Like Greenwood.

(7).—AMERICAN CANON.

To the north of Greenwood, on the west bank of American Cañon, are several seam mines. The George, Smith, American, Conner's, and Mauley mines are all on the same belt, through which American Cañon has cut a natural section. It is farther west in the strike of the slates than the Cedarberg and Spanish Dry Diggings mines, elsewhere described. The American Cañon intersecting this series at a very much lower altitude, a careful examination was made of the seam belt as exposed to view, by the artificial and natural operations of water combined.

At the American mine (Smith Brothers) I obtained the following section:

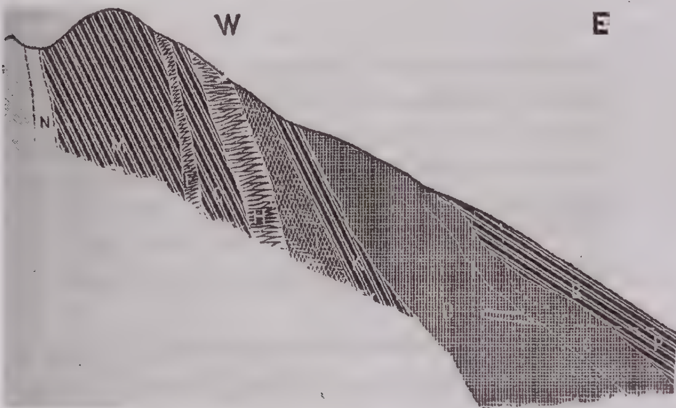


Fig. 12.—AMERICAN (SMITH) MINE.

P—Tunnel, 73 feet.
B—Slate.
C—Weathered trap, or "blue rock," impregnated with iron pyrites; outlines of mine.
D—More solid trap, impregnated with pyrites.
D C—Horizontal distance of 200 feet.
K—Slate (above the ditch), soft and decomposed.
J—Soap rock.
H—Flint rock; quartz.
G—Decomposed slate, like *K*.
F—Quartz ledge.
M—Slate for half a mile.
N—Soap rock, 75 ft.

George's mine is within a few hundred yards of the Smith mine.

(8).—AT THE CONNER MINE,

On the right bank of the American Cañon, a section was observed, consisting of decomposed ground entirely with slate on the east, and trap on the west. A westerly dip at the top of the mine visibly curves to an easterly one at the bottom. As products of metamorphism, the specimens collected here are interesting. Associated trap Curved strata.

(9)—AT THE MAULEY CLAIM.

On the south bank of the Middle Fork of the American, I observed the following section:

E.......................................200 feet...W.

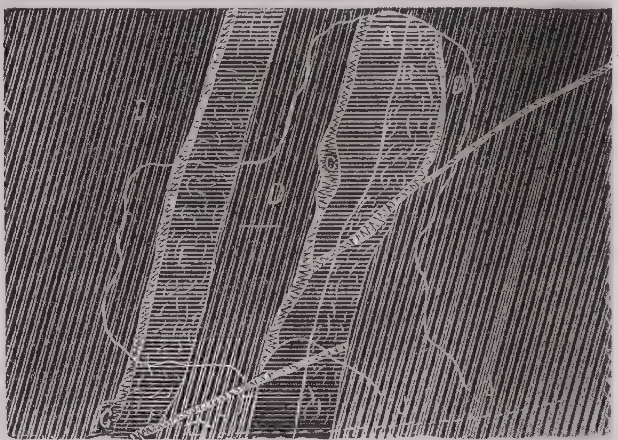


Fig. 13.—SECTION OF THE MAULEY MINE, ON THE MIDDLE FORK OF THE AMERICAN.

A—Vein matter (gouge, etc.), consisting of quartz in the hanging wall, and the usual soft, decomposed, red and yellow dirt of the seam diggings, 15 feet.
B—Well defined foot wall.
C—Quartz lenses.
D—Slate.
E—Irregular or massive decomposed ground accompanying the vein, occasionally showing lines of stratification parallel to the slates.
F—Cross course of quartz and decomposed vein matter.
G—Little vein or seam.
H—Nagler's house and trail to the Archimedes Vineyard.
JJ—Outlines of mine.

GENERAL SECTION ACROSS THE SEAM BELTS.

A natural or view section, at right angles across the seam-belts of this Divide, west of the Spanish Dry Diggings range of hills, and near the Middle Fork of the American, looking north, as deduced from the preceding observations, extending down to an altitude one thousand feet lower than Greenwood, discloses the following structure:

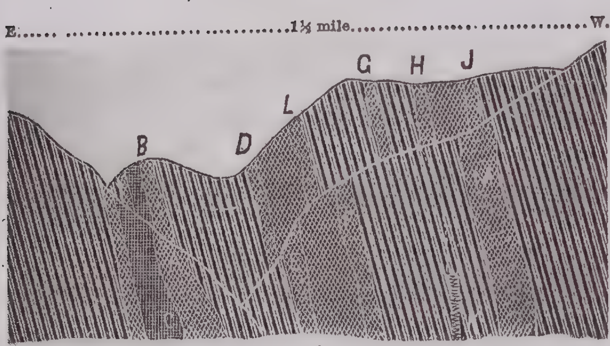


Fig. 14.—NATURAL SECTION AT AMERICAN CANON AND THE MIDDLE FORK OF THE AMERICAN.

A—American mine, in the same strike as the Greenwood mines.
B—Conner and Mauley mines, in the same strike.
C—Mines on the north side of the river, in the same strike.
D—Sliger.
L—Hines & Smith's diggings.
E—Atlantic and Pacific.
F—Cedarberg.
G—Waun (Taylor & Rice) and French Hill mines.
H—Grit.
J—Fargo.
K—Walker ledge, Rocky Chucky.
M—Young's dry diggings.

(10).—AT SPANISH DRY DIGGINGS.

Geological Features.—The Grit claim shows a pit about fifty by one hundred and fifty feet, and sixty feet in depth; and is, also, in the strike of the slates at their junction with a soap-rock belt. The pay-belt is about fifty feet wide. As at the Cedarberg, the slates are on the east, and the soap-rock on the west. This body of soap-rock runs to a point to the southward, in the town, at a distance of about two hundred feet from the claim. Soap rock

At right angles to the strike, going east, in a distance of about two hundred and fifty yards, some red-spotted slates set in, which continue around the south end of the soap-rock, and cut it off in that direction.

Veins only in depth

VEIN.—At the Grit there are no seams of any size, nor any signs of quartz noticeable above a depth of forty feet. At about forty feet below the surface there was some hard quartz, which occurred in several repeated swells or lenses, about three feet wide, and thirty feet long, perhaps one hundred feet deep.

The pay ran along the quartz, but was not in the quartz.

(11).—THE BARR & CROSSTON MINE

Is on the same belt, about two hundred yards horizontally north. (See under Yield.)

(12).—AT ROCKY CHUCKY

Veins crossing the Middle Fork

The vein crosses the river, and is there plainly observable. A number of small parallel stringers of quartz, five inches wide, is all that there is on the seam-belts at this altitude, although, according to one account, "a big ledge, eight feet wide," is observable somewhere in the same neighborhood. I was not able to visit the locality to see for myself. This is claimed by Mr. Walker, of Spanish Dry Diggings. It is visible on both sides of the river, and has paid largely.

Pay dirt

The pay dirt consists of a red, "scraggy" material, which may be traced up the hillside, in a manner showing that the gold is not of alluvial origin.

(13).—THE WAUN MINE

Seam series

(Taylor & Rice, formerly) is on a parallel belt, half a mile west of the Grit belt. Here are four series of seams, in a pay zone of fifty feet in width; running, also, in the strike of the slates, and dipping accordingly to the east about 80°. A pit of one hundred and

twenty-five by fifty feet has been hydrauliced into the steep hillside.

VEIN AND PAY.—Two of the pay seams are worked from the pit into the hill a width of three feet. About one hundred feet farther south (the river here running north) a tunnel has been run in at right angles to the seams, and one of the worked seams has been intersected and followed afresh, with highly remunerative results. It was paying richly at the time of my visit. Mining.

THE METHOD OF WORKING is by tunnels, cross-levels, and stopes. The pay was found in a series of little parallel veinlets running longitudinally, also in an intersecting series of veinlets of a uniform easterly and westerly course. Drifting.

(14).—THE FRENCH HILL MINE,

At Spanish Dry Diggings, is situated in about the same line of strike as the Waun mine, half a mile south of the latter.

The following section shows the character of the deposit just west of the blacksmith shop, on the road from the Spanish Dry Diggings to the Sliger mine:

W..............................290 feet..............................E.

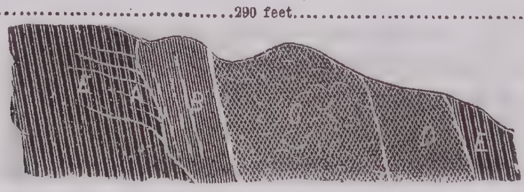


Fig. 15.—SECTION OF FRENCH HILL MINE, AT SPANISH DRY DIGGINGS.

A—Seams of quartz running off into the country rock, and forming rich pockets.
B—Quartz vein in parallel slate bands, 8 feet; comparatively barren.
C—Yellow and grey "porphyry;" (see under Lithology;) 70 feet.
D—Soap rock, 100 feet.
E—Slate.

Splits and twists.

The most fantastic forms of quartz deposit were observed in this mine. While the above section shows the general character and position of the vein, a walk of three hundred yards south to where the road to the Sliger mine intersects it, discloses a hydraulic face, with the following vein formation:

W.......................40 feet....................E.

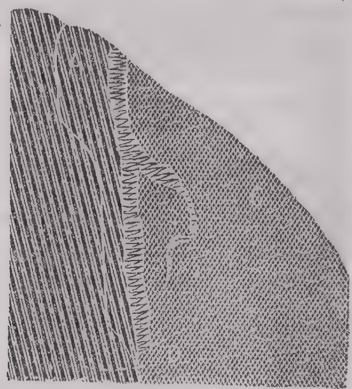


Fig. 16.—QUARTZ DEPOSITS, FRENCH HILL.

A—Slate.
B—Quartz.
C C—"Porphyry."
D—Road to Sliger mine.
A D C—Outline of hydraulic face.

At the northern end of the mine the quartz dips flatter, departing from the normal dip along the slates C, in the following figure, to take a twist (A) very much like that at D, in Fig. 14, at the same time sending off horizontal seams, branching as at B.

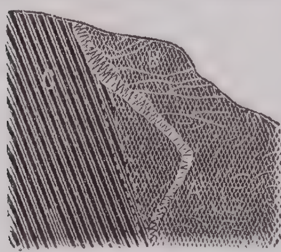


Fig. 17.—QUARTZ PECULIARITIES AT FRENCH HILL, SPANISH DRY DIGGINGS.

These sections show that the vein system of the French Hill mine has the soapstone deposit to the east of it, like the Grit and Cedarberg mines. The seams continue into the slates, on the west, undecomposed; but also into the yellow metamorphic zone, on the east; though they are themselves in a decomposed state—a fact proven by the existence of gold in quantities perceptible in hydraulic mining. Soap rock.

(15).—THE SLIGER MINE

Shows, in the tunnel, three hundred and seventy-five feet from the surface horizontally, and two hundred feet below the surface vertically, a heavy quartz ledge (B) of solid white quartz, ten feet and seven feet wide at the bottom and top of the tunnel respectively. It is bounded on the west by a very hard trap (A), and on the east by a soapstone or talc zone (C), one hundred feet wide. At the bottom of the old shaft (F), the vein was reported to me four feet wide, being drowned out at the time. At the average natural surface of the ground, it was two feet wide. Heavy quartz ledge.

W................150 yards.................E.

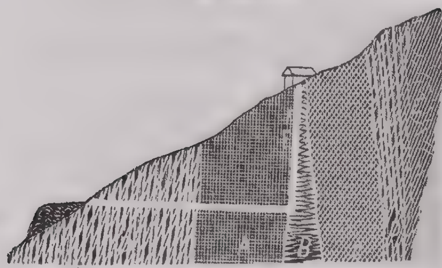


Fig. 18.—SLIGER MINE.

A—Trap.
B—Quartz (solid.)
C—Talc.
D—Slate.
E—Seams of Hines & Smith's mine.
F—Sliger shaft.

The pay in the Sliger mine is in the foot wall, and in the form of chutes dipping toward the north on the vein. The same rule as to the dip of pay chutes is said to hold good in the Taylor and other mines on the Divide.

(16).—HINES' SEAM DIGGINGS.

Junction of seam-belts.

About two thirds of a mile to the northeast of the Sliger mine are situated Hine's Seam Diggings, on the same belt as E in the Sliger mine. This is worked at the Smith mine proper, situated several hundred yards south-southeast of the Sliger mine, near the Spanish Dry Diggings road.

The Sliger and the Smith and Hine veins come very near together at the Hine Diggings, where the dip of the seam worked by Hine is locally westerly, and suggestive of intimate relationship to the Sliger fissure.

(17).—OTHER MINES AT SPANISH DRY DIGGINGS.

There are three seam-belts at Spanish Dry Diggings, beginning at the west:

1. The Waun, or Taylor & Rice, and the French Claim belt.

2. The Grit and Barr & Crosston belt.

3. The Fargo belt, situated one quarter of a mile east of the Grit belt, and parallel thereto.

The Fargo belt is from fifty to one hundred feet wide, and has soapstone on the west, slates on the east:

(18).—ON THE EAST SIDE OF AMERICAN CANON—THE CEDARBERG MINE

WATER.—The Cedarberg was formerly considered a seam mine. It was discovered by Cedarberg and his partners by following traces of gold from the cañon up on the hillside to the vicinity of the ledge. After a long search in its immediate vicinity, failing to strike anything tangible, and coming to the end of their financial resources, they asked for and were allowed by the Water Company a supply of water for a day's prospecting, by washing away the whole surface dirt. Water for prospecting

THE LEDGE.—Their flume broke down, and the water then did the work in its own way, disclosing a ledge of two or three inches in width. This was followed down to a depth of about twenty-five feet, and from it and several small adjacent veinlets, parallel to the first, there was taken out from ninety cubic yards forty-five thousand dollars in a few months.

The vein had been worked, at the time of my visit, to a depth of two hundred feet, where it was two feet wide, and consisted, according to Halford, the superintendent, of solid blue and white quartz. On the one hundred foot level the vein specimens are less solid, and are considerably intermixed with slate. Improvement in depth

The quartz runs, according to Mr. Halford's state- Chimneys.

ment, in chimneys, measuring from fifty to eighty feet horizontally, and vertically to unknown depth As will be seen further on, I found similar chimneys in the Taylor and St. Lawrence mines.

Gold changing in depth

PAY.– The sulphurets follow the blue quartz, while the gold is in the white and pure quartz. Sulphurets are scarce. At the surface, the gold was in flakes and sheets. At two hundred feet depth, the character changed to crystalline, and irregular.

Along strike of slates and soap rock.

GEOLOGICAL FEATURES.—The course of the vein is about north 10° west, following the strike of the slates at this point. The vein is along the boundary of a belt of greenish soaprock, which also follows the strike of the slates (for a short distance, at least).

On drifting to the westward into the soaprock, at a distance of forty feet, there is met with, I am told, a barren quartz vein, seven feet wide.

(19).—ATLANTIC AND PACIFIC MINE

Fissure between talc and slate

The soaprock belt continues a distance in width of about three hundred yards horizontally to the west from the Cedarberg vein, where is situated, at the junction between it and the slates on the west, the Atlantic and Pacific mine, on a remarkably perfect, smooth-walled fissure, devoid of quartz. The Atlantic and Pacific Company have gone down several hundred feet without finding the ledge they had confidently expected to reach in that depth, and have latterly returned to their old prospect hole, further south on the same fissure, where they are following down a seam of quartz.

(20).—THE INTERNATIONAL MINE (BILTY'S)

Is situated between the Cedarberg and Greenwood.

The strike of the seam-belt is with that of the black slates; dip, 80° east. The principal vein of decomposed quartz, etc., is three feet in width. Along it there is a belt of metamorphosed slates, sixty-four feet in width, very densely impregnated with sulphurets. On the foot wall, or west side, the vein is followed by a zone of talcose rock Auriferous quartz, containing gold and sulphurets, is taken out in considerable quantity. The sulphurets are said to contain good pay. Vein seams and talc

(21) —THE WOOD MINE,

Alluded to under "Yield," is several hundred yards further south, and resembles the International in every respect.

(22) —ON DUTCH CREEK—THE TAYLOR QUARTZ MINE,

Situated south of the old Georgetown road, has been opened to a depth of two hundred feet, and worked north and south on the vein for a distance of nearly one hundred feet either way. There is a fine vein at the bottom, only one edge of which was visible in the shaft at the time of my visit. A thick gouge is in the hanging wall, into which the shaft is being sunk to a depth of four hundred feet, for the purpose of fully testing the character of the mine. The works show conclusively the repetition of lenticular masses of quartz. The quartz lies along a well-defined fissure, the gouges continuing along the fissures wherever the quartz gives out. The quartz pinched out one hundred feet south of the shaft, on the one hundred foot level. It narrowed in a similar manner on the same level north of the shaft. The ore pile contained plenty of rock in which gold was visible. Lenticular masses of quartz

Heavy barren ledges

Parallel with the Taylor mine, on the east, are numerous heavy quartz ledges, containing a more highly glazed quartz, comparatively barren

The Taylor vein is distinctly traced toward the south for a distance of half a mile to the

(23) —ROSECRANS' MINE,

Form of seam diggings

Which has been only prospected at the surface. One quarter of a mile further south, the same vein, along with the trap accompanying it on the west, is found in the form of porphyry and seam diggings, and has been hydrauliced off to the extent of opening a pit twenty by twenty feet, and ten feet in depth, with favorable results. A quartz vein, supposed to be an extension of the Taylor, accompanies the belt about fifty feet east of this pit.

(24).—CAROTHERS' DIGGINGS.

Related seam diggings.

Continuing still farther south in the same general strike, at a point about a mile west of Johntown, on the easterly slope of a hill, Mr. Carothers has struck good pay, and done some work, in prospecting a seam-belt, which appears to be similar in character to the Greenwood seams. It is said to have a large porphyry ledge on the southwest side of the best pay streak, which is itself a decomposed porphyry.

(25) —THE ISABEL MINE,

Solid vein.

Owned by Brewster, of Placerville, shows a quartz vein of three to five feet in width, situated in the same general strike of the slates, a mile or two north of St. Lawrenceville, and dipping easterly 70°. The course of the vein is south 27° east Mr. Derby, a resident

miner, believes it to be an extension of the Gopher mine, between Placerville and Uniontown, and on the same fissure as the Taylor mine. It has been worked to a depth of eighty feet, where the vein maintained a width of from three to five feet

At the Isabel Mill, one quarter of a mile south of the mine, there is what is known as the Blue Ledge, on which a shaft has been sunk to a depth of one hundred and twenty-eight feet. Enough money was taken out of this to pay for the erection of the Isabel Mill. It is a small vein of quartz, from six to eight inches wide; course, south 5° east, and contains galena and iron sulphurets. It has a decomposed zone of slates on the east, about forty feet wide Rich blue ledge

(26).—THE ST LAWRENCE QUARTZ MINE

Has been mined to a depth of six hundred feet, where there is a fine vein. It follows, in general, the strike of the slates, as plotted on the map, and establishes for itself the character of a true fissure vein by its variation in detail from the bedding of the slates; cutting across them diagonally occasionally, but following the strike in the main. True fissure vein

The lenticular masses of quartz described in this mine, along with the associated stringers or seams running off into the slates on one side, are so characteristic of both the seam-belts and quartz mines of Georgetown Divide in general, that the character of the St. Lawrence may be referred to as typical, geologically, of the veins and seam-belts on the Divide. Following, in most cases, some well-marked fissure, yet not uniformly precisely with the bedding of the slates, with accompanying metamorphism and branching of seams and string- Lenticular quartz

ers peculiar to the vein chemistry of the slates; I have set them down as in part, at least, true fissure veins. (See under IV, Geology.)

The following longitudinal and cross sections of the vein fully develope the fact that the quartz occurs in lenticular forms, not continuing for any great distance, but invariably found to come in again in similar bodies lying along the main fissure.

Gouge and slickensides

At a depth of five hundred and fifty feet in the main shaft the quartz had entirely given out, and gouge took its place, following an exceedingly well-marked foot wall. On the five hundred foot level, at a distance of one hundred and sixty feet north of the shaft, the quartz gave out, and there was in its place a five-foot gouge, showing slickensides on both walls. Before giving out in this direction, the quartz jumped several times from the hanging wall to the foot wall, and *vice versa.* Everywhere else throughout the mine slickensides were noted.

Original fissure

The *foot wall* is everywhere the strongest throughout the mine. The hanging wall is occasionally, to all appearance, repeated two or three times in parallel slickensides, seen in the gouge on the hanging wall, which run off at regular angles and inclose bodies of slate, separated by little lenses and stringers of quartz. At *M*, for example, on the hanging wall, the gouge is full of these seams; and there is no distinct line of demarkation between the vein and the slates. The vein material appears to branch off into the slates.

Philosophy of the seams

Characteristic facts

Wherever the quartz in these side stringers pinches out, the fissure along which it was formed runs uniformly down to the foot wall. At this point (*M*) the lense of quartz is on the increase as you go down, attaining

its greatest width about thirty feet lower; after which it wedges out gradually as far as the five hundred foot level, as represented.

Mr. Cocking, the underground foreman, states that they have never gotten into any regular hanging wall, so far as he has known

There are two chutes of quartz below the three hundred foot level. Above the three hundred foot level they run together into one.

Where the quartz runs out on the north, at L, J, and A, the characteristic of gouge coming in to take its place is everywhere the same, and precisely as observed at the north extremity of the four hundred foot level.

(GROUND PLAN.)

E..........................300 feet..............................W.

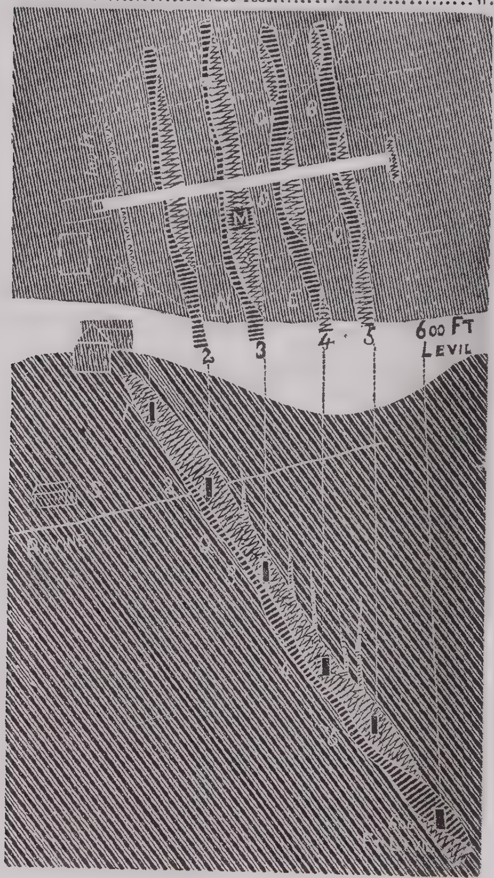


Fig. 19.—HORIZONTAL AND VERTICAL SECTIONS OF THE ST. LAWRENCE QUARTZ MINE.

The zig-zag lines represent quartz on the different levels, the outlines of which are indicated by the faint white line in the form of a double kidney.

A—2 feet gouge.
B—3 feet gouge.
C—3 feet gouge.
D—1½ foot gouge; 5 feet of quartz.
E—1½ foot gouge.

F—2 feet gouge.
G—4 feet gouge.
H—2 feet gouge.
J—4 feet gouge
K—2 feet gouge.
L—2 feet gouge.
M—Gouge in hanging wall, full of quartz seams, largest body of quartz 8 feet
N—
P—2 feet gouge.
Q—Gouge along foot wall of vein from 1 to 3 feet, average 1 ft.
R—Croppings
S—Boarding house.

(27) —SMITH'S LEAD,

(1 in the preceding figure) is a parallel vein, situated about one hundred yards east of the St. Lawrence. It is traced from the top of the St Lawrence Hill, at a number of points, by means of shafts on the surface, and is opened longitudinally by a tunnel, seven hundred feet deep, from Irish Creek, half a mile north-northeast of the St. Lawrence Mill, where Cincinnati Ravine, a branch of Irish Creek, cuts through the St. Lawrence system of veins, several hundred feet lower than at the mine. Accompanying vein

The north and east base of St Lawrence Hill, just above the tunnel, is strewn with vein-boulders from local veins and stringers on both sides of Cincinnati Ravine—the recipient of the metal accompanying this vein material, which, accordingly, paid very largely in placer mining days. Placer concentration

(28) —THE DONCASTER MINE

Is situated on the apex of a quartz hill, a mile south-southeast of the St. Lawrence mine. The shaft is ninety feet deep, on a vein of decomposed quartz, striking north 28° west, and dipping at the surface west 80°. Fifty feet west of the shaft there is an enormous parallel quartz vein, not less than twenty feet wide at the sur- Heavy quartz vein and associated seams

face, which also dips at the surface about 80° west. The worked vein has a distinct gouge at the foot wall, and a quartz vein eight inches wide. In an open cut from the Doncaster shaft-house toward the valley on the east, I observed the peculiar bend of the slates at the surface, which accounts for the westerly dip in the shaft and adjacent quartz ledge on the surface

One third of a mile east of the Doncaster mine, across the Kelsey road, there is a prominent quartz ledge striking in the same course, situated two hundred yards south-southeast from Martin's store. It is considered barren.

Paying

The pay in the Doncaster mine is said to be very good. Nobody knows the exact yield, but as Mr. Doncaster says he works on seams only when it pays, and as he pays his hands regularly every week from the resources of his mine, the presumption is that the reputation is deserved.

(29) —KELSEY'S.

Seams in strike of slates

The stage road from Georgetown to Placerville follows, from Martin's store to Kelsey's, the strike of the slates, which dip everywhere 75° to 80° east, and are intercalated with quartz veins and seams generally undecomposed, and in many places prospected by shafts, tunnels, and washings along the ravines.

Belt of metamorphic decompositions

Two or three hundred yards west of Kelsey's there is a decomposed serpentine belt resembling Greenwood porphyry, crossed in going from Kelsey's to Rich Flat. This has every appearance of being related to the Doncaster and St. Lawrence Hill vein-belt, and might belong to the Sailor Flat and Upper Johntown belt, if the metamorphic zones could be shown to be continuous for that distance.

The *Gopher Mine*, at Kelsey's, is said to have yielded some rock worth $30 a ton. Marshall & Co., have run a tunnel over two hundred feet long into the seam belt. The principal vein near town is about three feet wide, and consists of longitudinal intercalations with thin films of slate. The surface of the country has been washed away clean. Ledge

In the *hills to the east of Kelsey's* there are some very large quartz ledges parallel to the general trend. Three quarters of a mile east, at the head of Chunk Ravine, *Travers*, and others of San Francisco, have sunk a prospecting shaft ninety feet deep. Southeasterly from Kelsey's, high up in the hills, is situated the *Excelsior Mine*. None of these have, I believe, so far, yielded any pay above expenses. Hill Ledges

(30).—SEAM AND VEIN MINES ON PLACERVILLE DIVIDE—GEOGRAPHICAL RELATIONS

On the south side of the South Fork, in the vicinity of Placerville, there is a continuation of the seams and vein-belts of Georgetown Divide, with all their characteristics and peculiarities. A *decomposed belt* in the same strike of the slates as Kelsey's crosses the main street of Placerville at the Court House. The most noted seam-mining locality in the vicinity of Placerville is where Fisk, Sanders and Gilbert, took out large sums of money at the north end of Quartz Hill, about a mile from town. Seam and Porphyry Diggings

The general *seam zone* on both Divides, consisting of metamorphic or decomposed matter in the neighborhood of extensive quart veins, continues in the same strike to the Amador Mine on Sutter Creek, from which point the "mother lode" of the middle mining counties is plainly traceable in a further general continua- Large scale map of Mother Lode

tion as far as Mariposa County. The location of the latter was plotted by me in 1871, on the mining counties map in the Geological Survey office, from the borders of El Dorado County, south.

Connection with the Amador mines

Mr. Burlingham, Superintendent of the Taylor Quartz Mine, an experienced miner who has been over the country, and has especially observed the strike and continuation of the slates and seams, thinks that the identical belt on which Placerville is located, continues across the North Fork of the Mokelumne at King's Fork Junction and the South Fork of the Mokelumne at Bacon's Bridge, continuing thence through Plymouth to the Amador Mine.

Points certain and uncertain.

While the *identical continuation* is not a matter so easily made out, nor indeed very probable, the continuation of quartz ledges and of fissures and decomposed "porphyry" belts, with seam deposits in places, of the character of Georgetown Divide, situated in the same general strike of the slates, and in the same trend of vein formation and of chemical concentration of gold—in short, geologically identical rather than physically continuous—is a question admitting of no further doubt. It is assuming too much, however, to undertake to trace any where, for more than two or three miles, a perfect unbroken continuation of the identical veins, or seams, or "porphyry" belts on Georgetown or Placerville Divide. The general system, the geological position, and the chemical conditions of concentration and of precipitation of gold in connection with vein formation, are the same; which is all that can be said; and they are in continuation of the mother lode.

So far as my observation goes in the region represented by the accompanying map, the *trap* or green

stone "porphyry" accompanying the seam belts was not continuous, in the form of an "eruptive" dyke, which could be traced for any distance. There are occasional combs of metamorphism which have given shape to the hills, rising up in the form of undenuded crests. "Dykes"

Mr. Burlingham says he has observed that at the Taylor Quartz Mine he has trap to the west of the vein in which he is working, while at Placerville it is on the east, and at the crossing of the North Fork of the Mokolumne there is trap on the west again, which continues thence by way of Negro Hill and east of Nashville, between the two forks of the Mokelumne, always on the west side of the seam zone as far as the Amador Mine. Both East and West

Mr. Derby, of Isabeltown, says he has observed that on the Placerville Divide there is a *porphyry streak*, east of what he believes to be a continuation of the mother lode adjoining the Hodge, Lemon and Fisk mines, on the north end of Quartz Hill. It is, according to his observation, about fifty feet distant from these mines, east, and runs parallel, the porphyry itself being two feet thick. The mother lode at this point he measures as twenty-eight feet wide. [See sections below.] Companion "porphyry" ledge

Mr. Rodda, Superintendent of the St Lawrence Quartz Mine, agrees with Messrs Burlingham and Derby in the opinion that the Placerville and Dutch Creek veins, which strike through the Pacific Mine Hill, Quartz Hill, Poverty Point, Kelsey's, St Lawrenceville, &c., constitute a continuation of the identical mother lode of Calaveras County. Opinions of Miners

When it comes to the *connections in detail*, however,

Not made out

everybody disagrees, because there is no such connection. Like the "blue lead" of the ancient river system, it generally passes through the identical ground which is owned by the miner whose judgment is passed upon it. [See detail notes at Placerville, below]

The mines situated in this general zone are

Between the South Fork of the American and the North Fork of the Mokelumne, the Grosch, Drew, Harmon, Sheppard, Pacific, Epley, Miller, Snyder, and numerous others.

South of the North Fork of the Mokelumne, the Lucky, Baldwin, Bacon, &c. The Havilah, at Nashville, one mile west of the Baldwin, was, according to Burlingham, the first quartz mine worked in this State.

South of the South Fork of the Mokelumne the Enterprise, the Hooper, and one or two others at Plymouth; and then the Hayward at Sutter Creek.

VICINITY OF PLACERVILLE.

Continuousness of metamorphism

I examined only those in the vicinity of Placerville. That the soft, decomposed and metamorphosed slates and porphyry trend in belts showing parallelism and the same general longitudinal direction is evident. That they are in spots, and not necessarily connected, is the most reasonable conclusion to arrive at under the circumstances, the contrary not being apparent, nor capable of being demonstrated.

On this Divide, as on Georgetown Divide, the quartz is disposed to pinch out in lenticular forms, and chimneys, just like those on Georgetown Divide, and the ledges stand nearly vertical.

Ledges.

SOUTH OF THE TOWN OF PLACERVILLE *The Mitchell Mine* is nearest the town, being diagonally across the

road from the Court House; while the Epley, Pacific, and Harmon Mines, are probably on one continuous vein. The Mitchell and Poverty Point Mines may be a *very little* farther east in the same general zone of parallel veins. The Mitchell Mine has a knob of greenstone to the westward of it, forming the top of the hill south of, and in the rear of, the main street of Placerville. Ochery pockets, in connection with lenticular quartz, occur in it.

The German Company have run a tunnel from the east side into Quartz Hill, about 100 feet, and intersected on eighteen-inch quartz vein, which is succeeded on the west by a white "soap rock." A section across the hill at this point, shows the following structure:

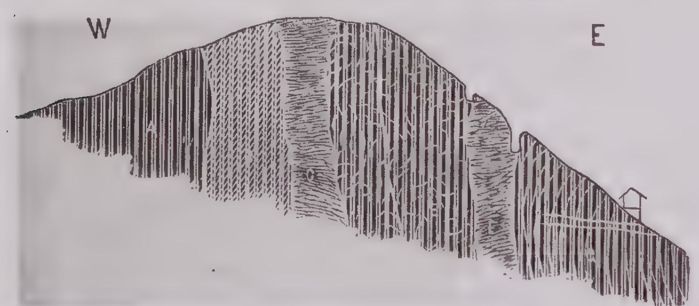


Fig. 25.—SECTION ACROSS QUARTZ HILL, AT THE GERMAN MINE.

A—Soft slates perfectly laminated and undecomposed.

B—Decomposed slate and soap rock zone, fifty yards wide, everywhere showing conformability to the dip of the slates. A few quartz veins of three or four inches thickness pass through it, striking N. E.

C.—Quartz ledge, thirty-five feet wide, called the Mother Lode.

D—Thirty feet of a yellow ferruginous crisp quartose rock, showing lines of slaty structure.

E—Soft, soapy slates, without seams, continuing down the hill to the ditch.

F—Dioritic trap masses, along quartz masses apparently related to the Fisk fissure. The strike of the quartz masses is very irregular; locally N. E; dip W. 100 yards south of the German Mine there is repeated a considerable body of irregular quartz trending E. and W. evidently an offshoot from the main vein in the hill, to open cut running North and South in continuation of the Fisk cut fifty feet.

G—Soft finely laminated slates to road, sixty yards.

At the Pacific Mine, a little farther south, there are two well marked ledges on the surface, fifty or sixty feet apart, accompanied by hydrous magnesian minerals and country rock, decomposed and metamorphosed after the usual character of the seam-belts.

The Brewster and LeMoile Mine, next south of the Pacific, shows an abundance of these.

North of the town the slates strike north five to fifteen west, dipping east 60°.

At the Fiske Mine, one quarter of a mile farther north, the worked vein strikes north $22\frac{1}{2}°$ west, and stands nearly vertical; on the surface, apparently dipping 80° west. A section across the same hill, at this point, shows the following repetition of the structure of the German mine, from which the continuousness of identical geological features may be observed:

W.................. about ½ mile.................. E.

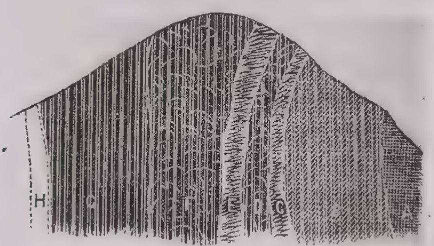


Fig. 19.—SECTION ACROSS QUARTZ HILL AT FISKE MINE.

A—Trap.
B—White, soft, soapy, steatitic, slate rock.
C—Seam opened in cut for half a mile.
D—Red and yellow decomposed slates; half porphyry.
E—Quartz vein.
F—Serpentine, etc., with trap masses in decomposed slate zone.
G—Slates.
H—Position of the Harmon & Gross ledges.

Open cut. The Hodge and Lemon Mine is an extension of the Fiske, forming the extreme north end of Quartz Hill. Seam mining has been carried on here to such an ex-

tent as to lay open to daylight half a mile of the principal seam or pay-vein of the district running in the strike of the slates. For several hundred yards an open cut exists, from 30 to 40 feet deep, with continuations in shafts, levels, and drifts under ground.

"Porphyry."

There are cross veins on the Hodge & Lemon ground dipping north 40°. Where these strike the foot wall or east wall of the porphyry, the pay is rich. They do not cut into the east wall of the vein at all. Porphyry is the designation here given to the vein-matter in the fissure itself. It is about four feet wide at the end of the hill.

The following is a natural or view section of *Poverty Point* from the Fiske mine, showing the continuation of the Fiske, Hodge & Lemon cut, on the north side of Big Cañon, through Poverty Point Hill:

Fig. 26.—POVERTY POINT, LOOKING NORTH.

A—Open cut running up the hill. A Spaniard, formerly working at point A, in the bed of the ravine, is said to have obtained and carried away, on one occasion, "a mule load of gold." He returned many years after, and again prospered for a time.
B—Ledges of quartz and trap.
C—Shaft house, mine on Poverty Point.
D—Soapstone belt, where prospecting shafts have been sunk.

Accompanying veins.

THE MOTHER LODE.—The strongest central body of quartz represented in the section, at the German mine, is considered by the miners (Mr. Marston, for example, whom I found at work here, and others) as the real mother vein of the southern counties; along the west side of which are situated the Epley, Pacific, Harmon,

Sheppard, and Gross mines, and along the east side, the Mitchell, etc.

The *Gross Mine*, on Big Cañon, one half a mile northwest of the Fiske mine, shows a ledge two inches to six feet wide, bearing rock containing $160 to the ton. It has been prospected for a distance of 1,000 feet.

The mother lode of Quartz Hill appears to *strike toward* the little flat just west of the road on the top of hill, at Kelsey's, and to be as near as possible in the same line of strike as the Doncaster and St. Lawrence mines. On the stage road from Kelsey's to Big Cañon Bridge, I observed, accordingly, in this zone, a section showing the character of its continuation in depth 1,000 feet lower than the hill at Kelsey's, and about 1,100 feet lower than the section at the German mine. No very heavy ledge is visible on the north side of the river, where the road descends. The quartz veins observed in the cañon of the South Fork resembled those Kelsey's and St. Lawrenceville

(31)- SAILOR FLAT AND UPPER JOHNTOWN.

Geological position

Returning to Georgetown Divide, and continuing eastward across the slates, we come next to the mines of Empire and Manhattan Cañons, Sailor Flat, Jones' Hill, etc These are situated nearly in the strike of the slates of Kelsey's; I was unable to determine in my own mind, without a more careful examination, whether the latter would strike in this direction, or toward Spanish Dry Diggings.

Old placers and shafts

The Sailor Flat mines have not been worked to any depth. Surface washing extends along this ravine for several miles, and numerous shafts and tunnels of ex-

ploration, the history of which it is now next to impossible to trace, are observable at every hand.

The point between Empire and Manhattan ravines is quartz seamed, the slates striking north 15° west. It is mined by hydraulic agency at two places—the Castile and the Hart mines.

AT THE CASTILE MINE there is a fissure or ore-channel similar to that of the Nagler mine at Greenwood, having two three-foot veins of decomposed material, separated by three and one half feet of slate. It is hydrauliced off 100 by 70 feet, and 18 feet in depth, the sluices draining east-northeast into Empire Creek, which is distant about 16 chains east. Ore channel

The Castile mine is the first of the series between Empire and Manhattan cañons, met with in traveling from Garden Valley toward the Georgetown and Greenwood road.

THE HART MINE has on the surface a seam formation, about 80 feet wide, which has been hydrauliced out longitudinally twice that distance to a width of 50 feet. At a depth of 95 feet, explored by shaft, the seams come together (according to Mr. Blasdel) in a nearly solid mass of quartz, over eight feet wide. It is several hundred yards north-northeast of the Castile mine, and has had washed off about 175 by 50 feet, and 40 feet in depth, of scarcely altered slate. Vein

THE CRANE'S GULCH, OR WHITESIDES MINE is also in unaltered slates, in a seam-belt which shows several strong parallel veins running through the middle of the mine in the usual direction. Owing to the course of the gulch, hydraulicing has been done crosswise of the belt. The pit trends in a southeastly and northwesterly Rich ore channel

direction. About 150 by 250 feet, and 70 feet in depth, has been washed out, which yielded $100,000.

JONES' HILL SEAM DIGGINGS are situated on the south side of Jones' Ravine, just across the ravine from the Jones' Hill gravel mines. (See under Gravel Mines and Yield)

(32)—THE SWIFT AND BENNETT MINE,

Paying seams

In the southern limits of Georgetown, is situated in a very narrow decomposed belt. It has recently paid largely. A rich deposit, containing "$1 to the pan," was struck near the road, 200 feet south of the upper working, at the end of the new tunnel, a distance of 98 feet from its mouth.

(33)—THE WOODSIDE LEDGE,

Quartz lens

Situated in Georgetown, is in the same range as the Swift & Bennett and the Keefer ledges. It stands nearly vertical, having a perpendicular shaft on the ledge Both hanging and foot walls are unaltered slate. It was worked to a depth of 100 feet some years ago, and also intersected with an incline 80 feet from the surface at right angles from the west side. The vein is in general two feet wide—sometimes three feet or four feet—and is in the character of a succession of kidneys some of which are very rich. At the bottom of the shaft there was a drift vein 30 feet north, where the quartz still continued, while near the surface, on running north, the quartz pinched out.

Pay chimney

The pay was in a chimney north of the shaft, which pitched north 30 feet in 110 feet, and was in the form of spangles or grains of fine gold, with occasionally a chunk of gold. Five or six inches of gold would hang together. The mine is unworked, being drowned out.

(34.)—THE KEEFER LEDGE,

Like the Whitesides, runs with the strike of the slates, and dips to the east about eight feet in 100 feet. It has been opened 140 feet deep, where the Georgia slide road crosses it. From the Keefer Mill Ravine a tunnel was brought in, which intersected the ledge at a depth of 25 or 30 feet. Size of the ledge at tunnel, eight inches or nine inches on one side, and two and one half to three feet on the other side of the tunnel. (Statement of Cushman, a miner, before the mine was closed.)

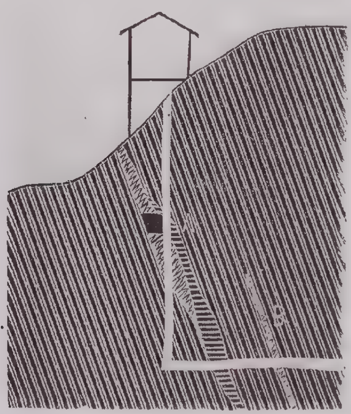


Fig. 27.—KEEFER LEDGE, GEORGETOWN.

A—Vein at tunnel, containing a body of quartz eight inches on one side and two and one half feet on the other; gouge of 18 inches on the hanging wall.

B—Rich streak of quartz parallel to the main vein, 14 feet east of it.

At a depth of 140 feet a little drift was run off to the east, the ledge having pinched out, though the gouge was still there. Fourteen feet from the main vein a little parallel streak of quartz was found; which was rich in gold. Then they run on the gouge 50 or 60 feet, and there was quartz above, but none in the drift. They drifted also two or three feet toward the north—and quit

work. A good deal of quartz was crushed at the Keefer mill, which paid. It all came from the ledge at a point near where the tunnel struck it.

(35.)—GEORGIA SLIDE—VEINS.

These diggings have paid largely, as elsewhere stated, for twenty years. There are three sets of seams in a country of metamorphic "porphyry."

The position of the two systems of veins, etc., is represented in the following plan.

Fig. 28.—DIAGRAM OF GEORGIA SLIDE,

EMBRACING TWO HUNDRED YARDS EAST AND WEST, IN A ZONE OF DECOMPOSED LIGHT COLORED SLATE, IN PLACES METAMORPHOSED INTO DIORITIC PORPHYRY, AND AGAIN PARTIALLY DECOMPOSED.

A—Town of Georgia Slide.
B—Parson's claim.
C—Beatty claim.
D—Pacific claim.
E—Mill.
B F—Zone of blue soapy slate.
F—"Sand streak" filling fissures of Vein System No. 1, and, like the quartz, jumping from one fissure to another.
1—Vein System No. 1; strike NE, dip NW 45°.
2—Vein System No. 2, smaller and nearly vertical; strike NW.
3—Vein System No. 3, in the strike of the slates, NNW; dip E 75°.

THE STRIKE of the slates is south 5° east, dipping east

75°. Vein system No. 1, in the Parsons claim, strikes northeasterly, and dips northwest 45°. In the easterly extension of the Parsons claim there are prominent several parallel dikes of "sand-rock," striking north 27° east, and standing vertically where I saw them.

The Pay is found on the side of the quartz, away from the sand-streaks, when these follow close along the veins of Vein System No. 1.

Ordinarily the principal pay, at B, is found at the junction of the two systems of veins (1 and 3), in pockets represented at *A*, Fig. 29.

W..............................10 feet..............................E.

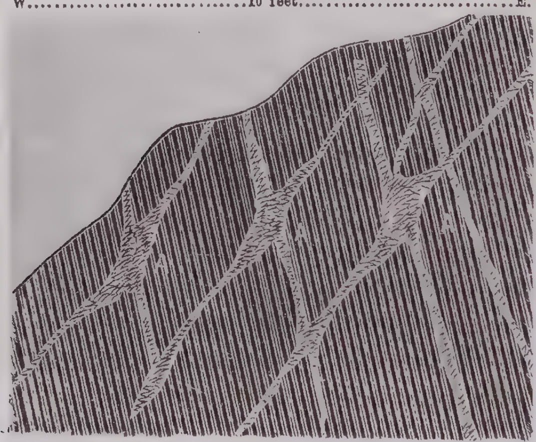


Fig. 25.—SECTION AT POINT B, IN PARSON'S MINE, SHOWING CHARACTERISTICS OF JUNCTION OF VEIN SYSTEMS NO. 1 AND NO. 3.

Sulphurets are found all through the adjacent slates.

Vein System, No. 2.—The following profile, taken from a point in the Beatty Claim, just in the rear of the quartz mill at E, Figure 30, looking north, illustrates the peculiar character of the quartz veins of Sys- Cross veins affected by the bedding of the slates

tem No. 2. The quartz runs for a while along the strike of the slates, and then jumps along irregular bendings to another parallel stratum or bench.

W.................................30 feet.......................................E.

Fig. 26.—SECTION IN BEATTY MINE,

SHOWING THE MANNER OF FORMATION OF QUARTZ KIDNEYS.

1—Vein system No. 1.
3—Quart kidneys conforming to Vein System No. 3 in part.
A—Lines of stratification.
E—Quartz mill.
B—Style of occurrence of croppings.

(36.)—THE BLASDEL MINE,

Two parallell veins.

On Dark Cañon, is on a seam-belt, having all the general characteristics of other seam-belts on the Divide. There are two hydraulic pits open on the north side of the hill 175 feet apart. Between these and extending over the hill for 2,000 feet north and south, prospecting shafts and cuts have been dug at intervals, demonstrating the existence of pay through the entire zone. There are two main veins or seam zones, each about eight feet wide. The most westerly vein or zone shows a series of "sand streaks" running east and west, dipping south 24°. The westerly decomposed quartz

Sand streaks.

vein is eight inches wide on the top of the hill; the easterly one ten inches. Both dip toward the east with the slates, nearly vertical. In this same range, across Cañon Creek, are other seam diggings, which I did not visit.

(37.)—BALD HILL.

The Maddox mine, on the southerly slope of Little Bald Hill, now worked by Frank Alters, is situated in a region of great metamorphism, the effects of which are observable to the summit of Bald Hill. A great variety of minerals are here found: crystallized gold, horn-blend, asbestos, actinolite, serpentine, talc, etc. The porphyry and vein courses, in crossing each other, form rich pockets or chimneys. The principal geological features are represented in the following diagram, from information furnished me by Mr. Alters: Magnesian minerals. Cross-course pockets.

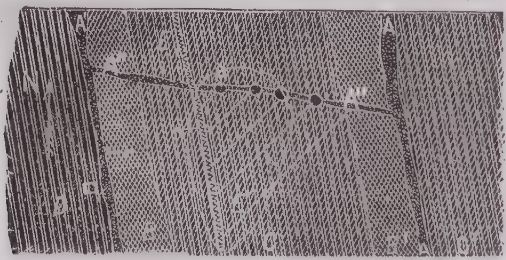


Fig. 37.—DIAGRAM OF THE MADDOX MINE, EMBRACING ONE HUNDRED AND FIFTY YARDS, EAST AND WEST.

D—Slates. Alter's house.

CC—Outline of surface washings of Alter's mine. The principal cut E is along a three inch seam of asbestos, occurring along with quartz in lenticular masses. The lines designated by E′ are cross courses of asbestos and quartz, which do not, however, continue to the west of the vein E. The principal pay in this mine is found at the intersections EE′, and E′A″, where numerous shafts have been dug.

A—Sand streak or "porphyry" in strike of slates, dip E 60°.

A′—Sand streak or "porphyry," parallel.

A″—Cross course of porphyry.

B—Soap rock, in the hanging wall of A.

B′—Soap rock in the foot wall of A′.

C, C′—Green magnesia rocks; being a metamorphic zinc of the slates; rich in sulphurets of iron along the asbestos and quartz seams; 600 yards.

(38.)—CLIPPER LEDGES.

Pay in an E & W ledge

At the Clipper Mine there are two ledges. *The best paying ledge* runs nearly east and west, and dips south 45° A shaft has been sunk 115 feet. The vein is twenty inches to two feet wide, and in bunches and lenticular masses, sometimes four or five feet wide, sometimes as small as six or eight inches. A well developed gouge accompanies it. *The main ledge*, however, runs north northeast and dips east about 15 feet in 100, having a width of two feet and over. It is considered barren. Although these courses correspond approximately to similar courses in Georgia slide, the dip in each case varies.

(39)—VOLCANOVILLE

Lenticular Quartz, in fissure

The McKusick Ledge, near Volcanoville, runs with the slates, locally at least, north 20 west, and dips southwest 75° or 80°. It is two and a half or three feet wide; in some places four or five feet; in others again only one foot. A shaft has been sunk on the ledge to a depth of 90 feet and a tunnel run in 100 feet lower from the southeast. At the point of intersection by the tunnel the ledge was only one foot wide, but on drifting along it 78 feet towards the north it widened to five feet; while in drifting the same distance towards the south it decreased to nothing, though *the walls remained perfect*, and from two and a half to three feet apart, filled with gouge. The foot-wall is the best defined. The rock pays from $13 to $14 a ton.

(40) —THE TRENCH LEDGE,

Metamorphic belt west.

Several hundred yards north-northwest of the McKusick ledge, on Quartz Cañon, runs north 5° west, dipping east 45°, along a metamorphic, trappean belt,

which accompanies it on the west, with serpentine beyond; and is from one foot to six feet in width, varying. On the east are slates. This mine was made famous, in the early days of quartz mining, from the circumstance of a sheet of gold having been found on it, lying very nearly horizontal. When worked, it paid $70 a ton. Many small veins and strings of quartz run off from the main ledge. The gold was generally found in isolated nests and bunches, of extraordinary richness.

4.—EXTRACTION AND REDUCTION.

(a) —EXTRACTION AND REDUCTION COMBINED, BY NEW METHODS

Economy in practiced methods

The means, methods, and costs of extraction in general vary greatly, always according to the nature of the deposit which is exploited. In beds of coal and iron ore, lying flat, or very thick, and in ordinary ledges of any width, the precedents of successful working have been so common, both here and elsewhere, as to have reduced the economy of mining on the Pacific Coast, by this time, to a science, peculiar to our conditions. [For costs, etc , see Tabular Exhibit, Subdivision V.] A great school of practical men and experts has been built up, in both branches of extraction and reduction.

Where the old methods would not pay

But new conditions, new necessities, and the application of new principles, are constantly revolutionizing things. Hydraulic mining heads, of from 400 to 1,000 feet pressure vertical, invented by daring men to transport cubic acres through tunnels—like the camel through the eye of the needle—are not at this day quite as hair-brained a conception as old school pit-miners and hydraulic engineers once would have considered them.

The principle of hydraulicing out the veins of Mother

Earth herself; of tearing down and transporting the bedrock slate, with all that in them is, has been applied on Georgetown Divide, in violence to all preconceived notions. (See under "Water as applied to Mining," Subdivision V.) Employed for a specific purpose—the gathering in of all the benefits of Nature's work upon these extraordinary ore-channels, and laying open preliminarily for following down the richest deposits into depths, beyond the reach of the pipe, wherever it may pay—the conception is as thoroughly practical as it is original and bold. It is applicable only in the mountains, of course, where there is the advantage of an abundant grade To the miners of Georgia Slide is due the merit of inaugurating and of carrying on successfully, upon a grand scale, this novel method of vein mining during seventeen years past. And to the appreciation of the resources of Georgetown Divide by James P. Pierce, along with the methods of getting at them by the application of agencies which cost nothing, yet are unlimited in the forces and quantities applicable, is due the credit of such development by the California Water Company of the resources of the country, as their operations described in this Report, may promise.

New adoptions of means to end

Successful results

Georgia Slide for a long time constituted the only "seam diggings" in the country. These mines were discovered from Georgia Flat, near the bed of Cañon Creek, where a portion of the hill had slidden down from the seam-belt. The pay as found, is regular and easily followed.

Method pursued at Georgia slide

The method of working is by hydraulicing, combined with shafting and drifting, wherever the local deposit is unusually rich. Subsequently the side seams and the

entire country rock thus opened up, are piped down as far as there is any outlet grade.

The Parsons claim has been worked in this manner for twelve years. It was originally the Webster claim. Before this character and method of mining were understood, it had been abandoned by the original owners *as worthless.*

Hydraulicing has paid well at the French Hill mine, Greenwood; at the Davis claim, Spanish Dry Diggings; at the St. Lawrence mine, Greenwood; and it has paid steadily from the first at Georgia Slide, where there is grade enough left to continue mining by this process for many years to come.

(c).—PRINCIPLES OBSERVED TOUCHING UNDERGROUND EXTENSION.

In underground extensions, of course, there can be no difference in this from ordinary quartz mining, as to principles employed. Nor is there any difference of principle in seam hydraulicing, so long as it continues above ground, from ordinary gravel mining. The conditions of seam mining differ from gravel mining in this: Underground extension.

1. That you cannot proceed to wash away the whole hill indiscriminately; for you would only be washing away barren country in one case, while in another the fine gold, or the nugget boulders, would be swept wholesale through the sluices. Limits to hydraulicing

2. That your pay does not run along the surface of the earth *horizontally*, like the gravel deposits, but *continues vertically*, in a narrow pay channel of quartz seams, related to some well-defined fissure or wall, which sometimes cuts off all seams on the one side, and always pitches at a steep angle. Pay running horizontally and vertically

Form of pay deposits

3. If you follow the pay under the ground, it is not always closely confined within two perfect walls, but often disseminated in a space of from twenty to fifty feet on the one side, or on the other, of the main fissures. It is generally in association with a series of lenticular masses of quartz, lying or crossing parallel to each other, and having the same dip; and in the form of pay chimneys, located where some other system of courses of quartz veinlets, or porphyry, crosses the former. Although these courses are continuous in threads, the tendency to form lenticular masses makes pockets of quartz at the crossings, and the gold deposits are accordingly in the form either of *sheets, chimneys, or pockets.*

(*b*).—PRINCIPLES OBSERVED IN SEAM MINING

Where it is, there it is

In order to discover and disembowel these sheets, chimneys, and pockets, wherever found, only one rule of mining applies, viz to follow the deposit, wherever you find it, to whithersoever it leads.

If you are near the surface, and the ground is decomposed, or the pay deposits are numerously and widely distributed, it is a very economical method to remove the entire hill with water, which does the sorting and separating in the act of moving. (See Concentration, under Practical Considerations, Sub. VIII.)

Framework

As soon as the deposit is beyond the reach of the water, the pay must be followed down by shafts in the usual way, and prospecting levels along the strike of the belt, connected with prospecting drifts right and left, at right angles to the lenticular masses you are in search of. These must be systematically run ahead, in

order to discover the pay wherever it has been interrupted.

Often these lenses measure only a few feet each way; no less frequently they measure forty feet in length and depth, and a few feet in thickness. Hence, the shafts, levels, and drifts ought not to be more than forty to sixty feet apart at the farthest; the drifts being located at such points in the shafts and levels as may seem most promising to intersect the principal pay seams. The latter are then to be followed as long as the pay lasts. Operations adopted to deposit.

Doubtless there are plenty of seams in the country which will develop into something like regularity and certainty in the nature of these deposits. So that, as soon as these seams are thoroughly understood, mining may be pursued permanently in them with profit. Permanent mining

(*d*).—DO THE SEAMS CONTINUE IN DEPTH, OR UNITE INTO A SINGLE VEIN?

This becomes a question of great importance It matters little whether the pay is found in a solid quartz vein, or in lenticular masses. The question is whether it is continuous and regular in depth, and sufficiently confined, or concentrated in character, to justify following it with shafts, levels, and drifts. As this is a question which only the local conditions of mining and the character and richness of the seams themselves can solve, the best solution I could give of it in this Report was to furnish a particular description of the character of the several deposits, in the mines I visited. The geological sections observed answer it so far as erosion to 1,000 feet depth is able to testify. Sufficient to justify mining

In the tabular statement following, there are many re-

Cases cited. peated instances of veins uniting in depth, and especially of the "companion talcose vein," which in many particulars resembles the seam diggings, uniting with the mother lode in depth.

How facts answer the question affirmatively

If any of these mines, or related mines of the Divide which I have described, are in good repute as paying mines, then the question answers itself affirmatively, in all that is of any consequence to the miner. If they are found abandoned, the chances are still even that it is owing to the miners' most common and well-known lack of that quality which is also lacking in poets—the capacity to do business unimaginatively.

(e).—REDUCTION BY CONCENTRATION AND CHLORINATION.

Sorted material of the seam diggings

AT THE BEATTY CLAIM, Georgia Slide, there is a five-stamp mill, which was erected many years ago. It is used occasionally to crush accumulated nugget rock, sorted aside from the hydraulic pits. Great judgment, and even skill and experience if possible, in the arts and methods of separation and concentration, are requisite for the proper treatment of the material of the seam diggings, before or after it goes into the sluices.

Items of cost

AT THE CEDARBERG MINE there is a ten-stamp mill, which crushes ten tons a day (yield $475), at a total cost for fuel, labor, and running, of $20 per day, or at the rate of $2 per ton. Cost of mill, at usual prices, $6,000; actual cost to the company (having been put together second hand) was only $1,700. The mill has a fifteen horse power boiler and engine, though an eight-horse power would do. Total employés in mill and mine, 26; wages, $3 per day.

There is also a five-stamp mill at Jones' Hill, owned by Hall, Beebe & Co.

AT VOLCANOVILLE there is a ten-stamp mill, owned by Maurice Dore. (For mills in the county generally, see under VII, Financial and Statistical.)

ON THE EUREKA LEDGE, the first northern extension of the Whiteside mine, Georgetown, the sulphurets were saved some years ago, and assayed with care. They yielded from $75 to $2,700 a ton, including at the latter figure, of course, some of the free gold as well. For a time this ledge and mill, in 1870, paid at the rate of 25 ounces per week. Sulphurets.

ITEMS AND COSTS OF CRUSHING.—It will be easy to memorize that stamps weigh 500 pounds; drop 50 times per minute; fall, *one* foot; require each *one* horse power to crush *one* ton in twenty-four hours; consuming *one* tenth of a cord of hard wood, worth *half a dollar*, per ton crushed; that water power costs just *half* as much; and that the labor item is *three fourths* of the cost of milling. But the average weight of stamps is somewhere between 500 and 1,000 pounds, while the speed, execution, and costs are in the same proportion; so that *for every* 100 *pounds of stamp there are crushed* 100 pounds in half a day (of six working hours). Average results from statistics in proportion to execution

From Deetkens' figures, in "U. S. Mineral Resources, 1873," the most elaborate and reliable ever prepared in California, being based upon operations at Grass Valley, I deduce the following:

THE COST OF MILLING is now $2 per ton; but this figure can certainly be reduced in labor account, by projected labor-saving improvements, to $1.64 steam, or $1.23 water power, per ton; allowing in the latter case for the for the use of the necessary water-heating apparatus. At Grass Valley

Cost of Concentration. Labor, 12½ cents per ton of $12 50

rock crushed, yielding about one per cent. sulphurets, (20 pounds, equal to one hundredth of a ton); or $12.50 per ton of sulphurets, worth $200 at least.

$11 08. *Cost of Chlorination of Sulphurets,* $11.08 per ton; of which $4.87 is for roasting, chlorination proper being only $2.21 per ton. Loss five per cent. as compared with fire assay.

(*f*) —AVERAGE MINING, MILLING, AND YIELD, IN 1861.

Twelve years ago From statistics of thirty mines. situated in eight different counties, reported thirteen years ago (in 1861), mining then cost an average of $6 per ton, milling $2.50, and the average yield of rock worked at the mills noted was $22 per ton In eight mines, however, the the cost of mining was only $2 to $3 per ton; in fifteen mines the yield averaged only $10 per ton; and in several mills the cost of treatment was less than $1 per ton.

(*g*).—TABULAR EXHIBIT OF MINING, 1873

Authorities The material of the accompanying tabular exhibit is based in part on personal observations, and on various sources of reliable information that have fallen in my way, principally the authorities in "Statistics of Mineral Resources of the United States."

.ND MINING,

Diagram of VEIN ZONES and VEIN SYSTEMS.

ıts have been granted. L..Lassen's Butte. B.B...Black Butte.

.ating and slate in spots.

TABULAR EXHIBIT OF VEINS AND MINING,

ACCOMPANYING REPORT ON GEORGETOWN DIVIDE.

BY AMOS BOWMAN.

[illegible]..L. L. Robinson's & Hall McAllister, N 43½ W.
[illegible]..L. L. Robinson and H. McAllister, N 56 W.
[illegible]..N 30 E.
[illegible]..A. Gem, N 60½ W.
Gray Eagle..John H. Walker, N 39½ W.
[illegible]..Wheeler Schofield, N 60 W.
[illegible]..Jas. Johnson, N 60½ W.
[illegible]..O. H. Kelley, N 67½ W.
Northern Light..E. T. Nye, N 88½ E.
[illegible]..N 82 E.
[illegible]..Co., N 12½ E.
[illegible]..Co., N 76 E.
Spring Valley..John Nash, N 15 E.
[illegible]..N 13 E.
[illegible]..Wm. Wall, N 9 E.
[illegible]..Co., N 7 E.
Galena..Robert Wall, N 41½ W.
[illegible]..Wm. Wall, N 12½ W.
[illegible]..H. G. Cozzel, N 1 W.
[illegible]..Co., N 14 E.
[illegible]..John Ferrett, N 48 W and N 31½ W.
[illegible]..J. T. Mahon, N 37½ E.
[illegible]..Co., N 54 E.
Spring Hill..Spring Hill Co., N 31 E and N 37 E.
Oneida..Oneida Co., N 28½ E and N 31 E.
[illegible]..Co., N 66 E.
Keystone..Keystone Consolidated Co., N 42 W.
Original Amador..Original Amador Co., N 3 W.
Spring Hill and Geneva..Spring Hill and Geneva Consolidated Co., N 8 W.
[illegible]..Otto Walter, N 3 W.
[illegible]..N 10 E.
[illegible]..George Hancock, N 8½ W.
[illegible]..Enterprise Co., WNW.
[illegible] Copper..J. McC[illegible], N 37 W.
[illegible]..Samuel Bright, N 41½ W.
St. Lawrence..Robert [illegible], N 16 W.
[illegible]..John A. [illegible], N 15½ W.
[illegible]..Abram Shear, N 61½ E.
[illegible]..W. Campbell, NE.
N. Y. [illegible]..A. [illegible], N 46 W.
[illegible] Co., N 0 W.
[illegible]..J. P. Rodgers, N [illegible] W.
[illegible]..O. T. Wheeler, N 8 E.
[illegible]..Alphonso Moorehouse, N 18½ E.
[illegible]..Geo. W. Simpers, N.
[illegible]..[illegible] Daughart, N 40 W and N 67½ W.
[illegible]..D. F. Richimpes, N 11½ W.
Calaveras..Calaveras Co., N 48½ W.
Tecumseh Silver and Copper..Tecumseh Co., N 28½ W.
Bobby Burns..Bobby Burns Co., N 60 W.
Tyson Iron and Copper..Jas. W. Tyson, N 18½ W.
[illegible]..A. E. Gifford, N 53½ W and N [illegible] W.
Wisconsin..Wisconsin Co., S. 30 E.
Independence..Independence Co., S. 30 E.
Lucas..D. S. Redman, N 10½ E.
Union Copper..W. T. Glidden, N 45 W.
[illegible]..E. A. Lewis, N 6 E.
Stickle..Stickle Co., N 51½ W.
Finnegan..Finnegan Co., N 17 E.
Carson..J. C. [illegible], N 8½ W.
[illegible]..G. C. Putnam, N 41½ W.
St. John..F. J. Carson, N 54 W and N 61 W.
San Bruno..J. R. Snyder, N 50½ E.
Eclipse..M. L. Bradley, N 37 E.
Eureka..George D. Trent, N 28½ W.
Confidence..Confidence Co., N 14 W.
Yellow Jacket..Jas. Tryson, N 3 W.
Keystone..Keystone Co., N 51½ E.
Cape..Geo. M. Tollan, N 37½ W.
[illegible]..Michael McBride, N 31 E.
North Confidence..North Confidence Co., N 8½ W.
[illegible]..M. Dodsworth, N 60 W.
O. [illegible]..[illegible] Co., N 56 W.
[illegible]..F. A. Wilson, N 61 E.
Waters..Wm. F. Waters, N 84½ W.
[illegible]..L. M. [illegible], N 9 W.
El Dorado..O. G. Blanchard, N 27 E.
Coyote Hill..C. B. Thompson, N 10 W.
[illegible]..M. Dodsworth, N 32 W.
[illegible]..Theo. Smith, N 54½ E.
Green Walley..J. W. Bobley, N 67½ W.
Wet Gulch..J. Seadman, N 75 W.
Maryland G. M...Wm Jones, N 64 W.
[illegible] Copper..A. G. Wiss, N 24 W, N 54 W and N 4½ E.
Ophir..Ophir Co., N 80 W, N 60 W and N 70 W.
Last Chance Copper..Last Chance Co., N 73½ W.
Plymouth Rock..J. R. Matheny, N.
Dover..Dover Co., N 45 W.
Central..Wm. Gwynn, N 56½ W.
Marietta G. and S...Marietta Co., N 10 W.
Port Yuma..H. M. Staples, N 7½ E.
Empire..M. Malick, N 10½ W.
Sulphuret..Marietta Co., N 16 W.
Mahoney..J. Mahoney, N 81½ W.
[illegible] & Wetmo..C. H. Dewey, N 50½ W.
Mammoth..Clinton Kerby, N 68½ W.
[illegible]..S. Dabovelain, N.
Old Pioneer..H. C. Downs, N 47½ E.
Uncle Sam..H. B. Fowler, N 8½ E.
Dr. Hill..J. E. Doe, N 24 E.

Fig. 32. MAP showing the LOCATION and course, by instrumental survey, of 100 gold mines in the Amador, etc., district of California, in which U. S. Land Patents have been granted. L..Lassen's Butte. B.B...Black Butte.

☞ The upper section represents slate predominating and granite in spots. The lower section represents granite predominating and slate in spots.

☞ Mines printed in Italics below, are all on veins that have been located instrumentally; their relative position and strike being platted on the Map.

[illegible]	[illegible]	[illegible]	Inclosure	Dikes	[illegible]	[illegible] Characteristics	[illegible]	[illegible]
[illegible]	[illegible]	East and west of all [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	From 1850 to 1864 [illegible]

1.—MINES IN EL DORADO COUNTY.

VEINS.	GEOLOGICAL FEATURES.							MINING AND MILLING.				YIELD & PROFIT.			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

6.—GRAVEL AND PLACER MINES.

1.—OF GEORGETOWN DIVIDE.

The placer mines of Georgetown Divide are situated at Wild Goose, Hogg's Diggings, Centreville, Five Cent Hill, Jones' Hill, New York Hill, Volcanoville, and Schlein's Diggings; beside which there are numerous shallow ravine placers, which were worked out in early times. Grand ravine

The ravine mines were wholly, and the gravel mines in a large measure, indebted to the underlying seams for the gold they contained, or may still contain.

In the pliocene period there were two streams in the principal gravel region of Georgetown Divide, where now there is only one. In other words, the North Fork and the South Fork of the Middle Fork had their junction opposite Georgetown instead of opposite Mount Gregory. The ancient South Fork is represented by the Mount Gregory gravel range. Pliocene streams

Darling's Ranch and Jones' Hill gravel range represents both Otter Creek and Cañon Creeks. Here are, then, two gravel ranges, corresponding to two ancient rivers, the one a broad stream, the other a tributary, of no great length.

The gravels of Schlein's Diggings show plainly that they are of local origin. Whether it was a branch of the Placerville stream, or the ancient Otter-Cañon Creek, is a matter of no consequence to the miner, except so far as the pitch of the bed-rock may furnish him with an outlet for his sluices without tunneling. Some of the gravels of Tipton Hill undoubtedly had their ancient outlet toward the north and west. Local gravels

The ancient cañon in which were basined the gravels

of Mamaluke Hill corresponds to the position of Oregon and Illinois cañons, and probably trended, like the latter, into the ancient Otter-Cañon Creek.

In the same manner Republican Cañon, on the southwest end of the Mount Gregory ridge, has its ancient repetition in the gravel deposits of Buckeye Hill.

Kentucky Flat and related diggings, at the head of Otter and Cañon creeks, both represent ancient tributaries to a small ancient river, these remnants of which only, are left.

Jones' Hill was below the junction of the ancient Middle and South Forks of the American.

(a).—THE MOUNT GREGORY RIDGE,

Pliocene south fork,

Representing the pliocene South Fork of the Middle Fork, has a general elevation of 1,500 feet above the Middle Fork, and a heavy gravel deposit of from 25 to 300 feet in depth, and six or seven miles in length, running east and west. Average breadth of gravel nearly a mile.

The mines tail into the Middle Fork of the American River on the north, and into Otter Creek on the south. Only the edges were worked in early times, yet there was once enough mining done on this ridge to create and to support very large and active populations at Mount Gregory, Volcanoville, Buckeye, etc.

Near Mount Gregory town.

Mount Gregory Ridge proper extends through sections nine and ten, township thirteen north, eleven east, and is flanked on the north by the Middle Fork of the American, and on the south by Missouri Cañon to its junction with Otter Creek. It is a very heavy gravel deposit, about two miles long and half a mile to three quarters of a mile wide, containing gravel from 10 to 250 feet in depth.

Formerly large sums of money were made here in the most primitive methods, by sluicing. On the south slope of the ridge the surface was washed away until the heavy deposit was reached, and after that drifting was resorted to. With local cañon water on some of the lower branches, spring water is still used for one day in the week, to wash out the products of drifting; and there is sufficient inducement in this to keep a number of miners lingering in the neighborhood. Southern slope

Upon the northern or Middle Fork side of the ridge little has been done in the way of mining. The hill has been pierced on both sides by numerous tunnels and demonstrated to contain rich deposits of gold. Northern slope.

The various diggings on this ridge are Gravel Point, Gardner's Point, Bitter's Point, Nameless Point, Carter's Point, Drummond's Diggings, Lloyd's Diggings, Webster's Diggings, Cooley's Claim, Bowman and Worthingham's Diggings, Garner's Claim, the Hercules Mine, etc. Diggings

VOLCANOVILLE is situated on the same ridge in section 8, T. 13 N., 11 E Still further west on section 7, and southerly in sections 17 and 18, also in sections 12 and 13, T. 13 N., 10 E., are gravel deposits of considerable extent, known as Miller's Diggings, Trench Diggings, Buckeye Hill, etc.; varying in depth from 15 to 25 feet. Near Volcanoville

BUCKEYE HILL is an isolated piece of ground several hundred acres in area, situated upon the extremity of a lateral ridge running southwestward from Mount Gregory ridge below Volcanoville. The gravel at this point has been drifted out in many places to 20 feet thickness. The material was taken out in the summer time, and washed in the winter time. Lower end

(b).—RIDGE PARALLEL TO MOUNT GREGORY RIDGE.

Jones' Hill Ridge.

Across Otter Creek is the Darling's Ranch, Bald Hill, and Jones' Hill ridge, representing the ancient Otter-Cañon Creek, which created and supported the mining camps of Boulder, Gopher, Mormon, Bald, Harrison, Cement, Bottle, Gravel, Mount Calvary and Jones' Hills; embracing an extent of country from five to seven miles in length, and an average width of perhaps half a mile. Besides the gravels on this ridge there are seam diggings at Bald Hill, near Cement Hill, and at Jones' Hill.

Jackass Hill, or Chris's Ranche, lies at the head of Otter Creek, near Kentucky Flat. Its channel seems to have a trend from east to west, connecting with the Boulder Hill deposit in section 27, T. 13 N., 11 E.

Boulder Hill is an extensive and deep deposit, favorably situated for rapid hydraulic working, being on a ridge between two deep gorges. On the northward of this hill there is a tunnel several hundred feet deep.

Darling's Ranch, west of Boulder Hill, lies in sections 28 and 29, T. 13 N., 11 E. Here occurs a large gravel ridge, near Darling's Ranche, which has been explored by numerous shafts and tunnels, proving the existence of gold in paying quantities. It can be opened favorably either from Cañon Creek or from Otter Creek.

Bald Hill, in section 30, T. 13 N., 11 E., has a comb of talcose slate and other metamorphosed rock, which deflected the course of the ancient channel, standing across it at right angles. Opposite to it modern denudation has carried away all signs and remnants of the ancient channel.

Harrison Hill is a continuous gravel ridge, contain-

ing a deep deposit, and extending east and west entirely through section 25, T. 13 N., 10 E.

Cement Hill, situated farther west on the same ridge, opposite Georgia Slide, lies in section 26, T. 13 N., 10 E., and is three quarters of a mile long by less than half a mile wide. Many years ago it was pierced by tunnels and the bottom stratum of gravel was extracted, yielding immense sums of money.

A description of this was given by Prof. Blake, in his Geological Reconnaissance of California. He says

"The Swiftsure tunnel is 120 feet in slate, and total 400 feet in length. The auriferous earth is found under a thick deposit of fine clay, 30 feet thick, in which whole trees are imbedded. * * * The clay differs from that at Mameluke Hill; it is nearly pure clay, with a reddish brown or drab color, and was evidently deposited in quiet water."

Nevada Flat is a lateral ridge, jutting from the south-western side of Cement Hill, and occupying a corner of section 34, T. 30 N., 10 E.

Bottle Hill Diggings occupy an area of about half a mile square, and have been celebrated for their yield. The North Star, St. Louis, Cuyahogo, Gravoy, and Hopewell tunnels, each extensive works, have pierced the Bottle Hill Channel from both sides; and the greater portion of the bottom stratum has been extracted by drifting. The channel is very deep, and, according to the popular belief, will pay throughout for hydraulicing.

Mount Calvary Diggings occupy the center portions of sections 27, 28, 33 and 34, T. 13 N., 10 E. The ground is principally owned by C. H. Calmes.

Gravel Hill, west of Mount Calvary, occupies a considerable portion of section 28, T. 13 N., 10 E.

The gravel covers an area of half a mile square, and is also deep.

Jones' Hill, in sections 20 and 29, T. 13 N. 10 E., is divided by a gulch called Jones' Cañon. That portion of the deposit on the north side consists of a heavy bed of gravel, while that upon the south side consists of seam diggings. The gravel is deep, and has been drifted out to a great extent. Area, one half to three quarters of a mile.

Mitchell's Flat, west of Jones' Hill, is of small extent, and constitutes the terminus of the ridge.

(c.)—GRAVELS ROUND THE HEADWATERS OF OTTER AND CANON CREEKS.

Kentucky Flat to Tipton Hill.

A series of "drift" deposits, which blend with the Mount Gregory Channel near its upper or eastern extremity, and having a total length of four miles, can be followed to Tipton Hill, though separated by the branches of Otter Creek. These include all the diggings situated between Kentucky Flat and Tipton Hill. Geologically this series does not differ from the gravels already referred to as forming the head of ancient Otter Cañon Creek.

North-westerly outlet.

Barometrical observations, made by W. A. Goodyear in 1871, proved that the stream which flowed in Tipton Hill Channel emptied toward the north and west; consequently that it was tributary to ancient Otter-Cañon Creek.

The McCall Claim, near Grey Eagle Bar, has been profitably worked with a small sluice head.

Branches of Cañon Creek.

Gopher Hill is situated in section 33, T. 13 N., 11 E., on a divide between two branches of Cañon Creek, having a favorable hydraulic opening on the north into

a precipitous cañon. The gravel deposit extends north and south a distance of about a mile. The eastern end is supposed to connect in some way with Kentucky Flat. A tunnel on the north and several shafts in the hill have demonstrated the value of the ground. On the southern end Currant & Cushman have made a small opening, with satisfactory results.

TIPTON HILL shows, at *Schlein's Diggings*, situated in section 3, T. 12 N., 11 E., the most extensive workings in the whole section of country near the base of Tunnel Hill. It is the southern end of a body of gravel, of which the Jones claim forms the northern terminus. With a pressure of sixty-five feet, a small quantity of water, and an eight-inch sluice grade, boxes sixteen inches wide, and without the aid of quicksilver, the average yield per day in these diggings has been six dollars to the man employed

Favorable results under disadvantages.

The water is brought in small ditches from near the head of Rock Creek.

The northern boundary of the section, in which Schlein's is situated, constitutes the northern boundary. This ground was until lately owned by the Schlein brothers; it now belongs to the California Water Company. Thence north on the channel there is a claim nearly a mile in length, upon which there is a shaft in gravel 120 feet deep, which has not reached down to bed rock. Upon its eastern side there is a tunnel 1100 feet long opening the ground, with an outlet into one of the branches of Rock Creek.

Deep unworked ground.

FORT HILL is situated farther west. The location is not accurately determined. On it there are many gravel claims, where drifting has been carried on to some

Drifted ground.

extent. The deposit is about one eighth of a mile wide and two miles in length, trending northerly and southerly.

Prospected ground.

BELL'S DIGGINGS, next west of Kelly's, in section 15, and a portion of 22, in T. 13 N., 11 E., are situated at the extreme head of Missouri Cañon. They have been prospected by a tunnel and many shafts, and found to contain gold in paying quantities. This deposit is supposed to have some connection with the Kelly deposit, and also with the Kentucky Flat gravel at its southern extremity.

Mingling with Mount Gregory gravels.

KENTUCKY FLAT is an extensive drift channel, having an average width of about three quarters of a mile. Its gravels are blended with neighboring deposits for a distance of five miles in a northerly and southerly direction, upon sections 34, 27, 22, and 15, T. 13 W., 11 E., mingling with the Mount Gregory gravels in section 10.

Among the claims to be noted here, that of A. J. WILTON & Co. has been prospected to a considerable extent, and is known to contain gold in paying quantities. The extreme southern end of the hill, at this mine, has been washed off. The gravel deposit is 10 feet deep; but farther north bed-rock declines, and the gravel thickens to probably 100 feet. A tunnel pierces the gravel for 1,000 feet. At this mine the deposit is only a quarter of a mile wide. Both north and south of it the area of country covered with gravel widens out.

Parallel to Mt. Gregory, with westerly outlet.

KNIGHT & JONES have worked on the south bank of Missouri Cañon, at a point a mile north of Wilton's. They have thoroughly prospected the ground, and established its value. Where the gravel deposit is intersected by Missouri Cañon, it seems to trend toward the

west, along the southern base of Mount Gregory Ridge, and to form a distinct deposit parallel to that of Mount Gregory. By actual survey, the vein-rock of Jones & Company's claim has been found to be 100 feet lower than at Wilton's, Kentucky Flat.

From the Knight & Jones claim, toward the west, through sections 20 and 21, T. 30 N , 11 E , as far as the junction of Missouri Cañon and Otter Creek, there are many small cañons tributary to Otter Creek which have paid richly, yet without disclosing heavy gravel deposits.

KELLY'S DIGGINGS are situated in sections 14 and 23, T. 30 N., 11 E. The gravel shows a depth from the surface to bed-rock of not more than six feet. It appears to be the extreme eastern end of the auriferous zone below Tunnel Hill. The deposit extends southerly to the north branch of Otter Creek, and toward the north and west blends into the Mount Gregory Ridge. The area washed is over 45 acres The gold was pretty generally diffused through the gravel from top to bottom, and the mine, according to Kelly's statement, paid from $15 to $20 a day to the hand. Shafts were sunk close by, disclosing the existence of a channel from 30 to 80 feet in depth, and one quarter of a mile in width. This deposit continues for about two miles from south to north.

Surface washing.

Deeper gravel.

(d)—OTHER GRAVELS ON GEORGETOWN DIVIDE.

MAMALUKE HILL AND BUFFALO HILL are worthy of especial notice. Mamaluke Hill was carefully examined in 1854 by Prof. Blake, having been drifted out to a large extent prior to that time. There is in the hill a gravel and sedimentary deposit 200 feet thick. Its

character proves it to be of local origin. The Mamaluke Company drove in a tunnel 800 feet long.

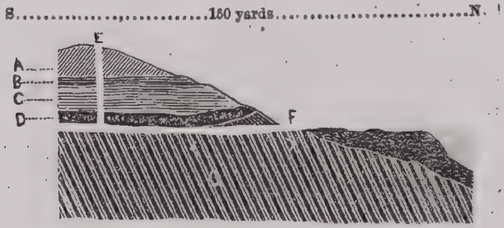


Fig. 28.—SECTION OF MAMALUKE HILL, NEAR GEORGETOWN.

A—Gray argillaceous beds with volcanic matter (cement) 40 feet.
B—Auriferous gravel, 8 feet.
C—Gray argillaceous beds, with volcanic matter, 60 feet.
D—Auriferous gravel and clay, on bed rock.
F—Tunnel.
E—Shaft.

Pilot Hill is the site of some gravel mining in an ancient channel of local origin. Before 1860, these mines supported a large and prosperous population. The gravel is from twenty to thirty feet thick, and contains many angular quartz bowlders and nuggets of gold. Since my visit, the principal ground has been purchased by the California Water Company.

(2.)—GRAVELS OF PLACERVILLE DIVIDE.

Heavy masses of pipe clay on the north rim of the pliocene south fork at Placerville near the head of the west branch of Cedar Ravine, show plainly enough that the principal ancient channel of the divide was further to the south. On crossing the ridge on the line of the stage road to Shingle Springs, the looming banks of Coon Hill hydraulic diggings testify to the central location of the ancient valley, as well as of the chief concentration of gold-bearing material in this vicinity—as clearly as the fact stated to me by Mr. Bishop, Superintendent of the mining company at work

at Coon Hill—on the authority of the company's books and other reliable accounts—that twenty-five acres of gravel removed from here by hydraulicing, have yielded a total of $25,000,000.

Touching the direction of this channel, Mr. Goodyear wrote, in the Placerville *Democrat*, in November, 1871: "It is extremely probable that a deep continuous channel, known here as the blue lead, extends from White Rock in a generally *southerly direction* beneath Dirty Flat and under the two intervening ridges to the extreme south end of Smith's Flat. But whether this channel from there on continues its general southerly course, coming out on the Weaver Creek side, at or in the vicinity of the old 'Try Again' tunnel, or whether it makes a sharp bend to the southward in Prospect Flat, is a question impossible to answer with certainty until developments have been pushed further underground." Course of drainage

Without attempting in connection with my Georgetown work, to trace the course in detail of this ancient river of Placerville Divide, I may say that I could look over the entire country from Grey Eagle Mountain and Robb's and Tell's Mountains, and was on the ancient channel of Placerville at two points, Sportsman's Hall and Placerville, and I have no hesitation in stating it as a fact that the topography of the pliocene period is preserved in the volcanic outflows, showing that the ancient south fork cannot have varied much in its general course from that of the south fork of the present day.

3.—PLACER AND GRAVEL MINES ON FORREST HILL DIVIDE

Forrest Hill Divide, like so many other mining regions of the Sierra Nevada, became almost depopulated after Depopulation.

the first historical era of gold mining in California. It is, nevertheless, one of the most productive mining districts of the State. Within half a mile of the town of Forrest Hill it has been estimated that from $5,000,000 to $10,000,000 have been taken out. The mines began to decline in 1858, at the time of the Frazer River excitement. Prior to that drifting was the customary method of working, and the lower strata of concentrated gravel yielded enormously.

Rich bottom strata.

Crystals of gold in placers.

In places on the Forrest Hill channel gold has been found in crystals along with quartz crystals, the angles of which only were broken off. This probably cannot have been situated on any central wash of the ancient channel.

The gravels of Forrest Hill Divide constituted the ancient middle and north forks of the *Middle Fork* of the American.

Yield, to be halved.

NEAR TODD'S VALLEY.—The *Dardanelles Mine*, with a frontage of 1,000 feet, reported $2,000,000; the *Jenny Lind*, with a frontage of 450 feet, over $1,000,000; the *New Jersey*, with a frontage of 600 feet, and from an area of 500x400 feet, $850,000; The *Deiderhimer*, $650,000; the *Independent*, $450,000; the *Fast, Rough and Ready*, *Gore*, and sundry others, each about $250,000; and many claims from $50,000 to $200,000 each. The Gore claim had a frontage of 100 feet and a depth of 200 feet in the hill. About $40,000 from the Gore claim was derived from a basin 380 feet square. The Independence yielded $10,000 from a space 20x20 feet. These reported yields might, perhaps, safely be halved.

Consolidation and drifting.

At Todd's Valley, Pond & Co. now pretty nearly monopolize all the mining ground. The town itself is comparatively depopulated. The Blue Gravel Range

Company occupies the ground of the old "Dardenelles," with Spring Garden ranche and the Powell Claim, embracing nearly two miles on the old channel. On the Powell claim a good many years ago a tunnel was run in 750 feet long, but it being found too high to drift the ground to the bed-rock, an incline was sunk from the end 120 feet, and a chamber was excavated, where hoisting and pumping engines and a chimney shaft were put in.

The *Mountain Company* have a tunnel in 2,600 feet, and a shaft down from the end 60 feet. They were reputed to be netting, several years ago, $1,000 per month. Drifting

All the claims on the Forrest Hill ridge extend through a big channel to the Devil's Cañon on the north. The tunnels were generally run in too high.

YANKEE JIM'S, another depopulated, historical town, has yielded its millions, and employed many thousands of miners for ten or twelve years. Bradley & Co. are of the few old companies which have continued working.

BATH had 100 inhabitants left in 1870. The pay is in hard cement, which has to be thoroughly slacked before washing. The Paragon Mill Company own here the principal lead, and have crushed the cement with profit. They worked 20 men day and night in 1870, and the mine was said to pay $200 a day. Cement

At MICHIGAN BLUFFS there is in sight an unusually large quantity of concentrated pure quartz gravel, which in the opinion of Prof. W. B. Blake is of local origin; though the fact that so little country rock is intermixed with a large quantity of thoroughly washed quartz boulders (if rounded?) would seem to imply that the Origin of gravel.

material had traveled a considerable distance. In the deposits of lighter material there is observable a diagonal stratification caused by varying currents; the evidence being in favor of a local northeasterly and southwesterly course of the channel, like that of the North Fork of the middle fork and its branches. The large boulders in other portions of the diggings testify to the presence, at the time of formation, of a very large quantity of water, and a violent transporting power.

Yield.

One of the claims yielded $48,000 in five months, to nine men employed night and day; at an expense of $13,000; leaving a profit of $35,000. The usual yield was formerly from six to eight dollars a day of ten hours work to the man; in some claims from $20 to $30. A four-pound nugget was taken out of these mines in early times, showing that a portion of the gold, at least, was probably of local origin.

7.—COPPER MINES.

Copper mining has been carried on in two or three localities on Georgetown Divide.

In metamorphic belt

THE BUNKER HILL MINE is situated three quarters of a mile south of the Georgetown road, near Pollard's, and is in a highly metamorphosed belt, running parallel to the trend of the slates in that region. A mill was erected upon the mine, but the works were abandoned, and the mill has gone to decay. The ore consists of sulphurets and carbonates.

With garnet rock

THE FAIRMOUNT MINE is situated on the road from Pilot Hill to Coloma, several miles from the South Fork of the American. A tunnel of considerable length has been run northerly into the hill. The works have been abandoned for many years. The ore consists

chiefly of sulphurets. Garnets occur in huge blocks two feet thick.

Copper mining, in the same general range of the slates, in the foot hills, has been carried on in numerous localities outside of El Dorado County. It is in the same zone of copper-ore deposits, and in about the same geological position west of the gold-vein series which has been worked in Amador County at the Cosumnes mine, near Michigan Bar; at the Newton mine, three miles from Ione City; and at the Copperopolis, in Calaveras County; and also near Round Tent, in Yuba County. Localities in copper belt.

THE COSUMNES MINE is in profitable operation at the present time. It keeps 40 men employed. The ore is reduced at the mine by smelting; the yield, by this process, being about 40 per cent. Smeltimg.

THE NEWTON MINE employs 25 men. The ore is worked by the leaching process, which saves 90 per cent. Leaching.

8.—IRON.

Iron ore of good quality, and in large quantity, has been found and explored to some extent, in Placer County, near Auburn. The locality is on the land of Lysander Utt, one mile north of Wells' Ranch, on the Grass Valley road, six miles from Auburn. There is on the hillside a mass 30 feet thick, of hemitite, perhaps intermixed with limonite. Iron ore here occurs in larger quantity than has been noted anywhere else in the slates, unless it be the deposits of Sierra County. Stock work.

Ilmenite, or titanic iron, has been found in large crystals in the gold sluices at Georgetown; and *magnetite* in the wall rock of the Trench lode, Volcanoville; also in Minerals.

fine octahedral crystals in slates near the Boston copper mine, in this county.

9.—CINNABAR

Ledges. Has been found in El Dorado County, in a ledge on the main ditch near Work's Ranch; in quantities believed by the owners to be workable with great profit, near Latrobe; also in a quartz vein in Mariposa County; and in the placer mining sluices at Grass Valley.

10.—LIMESTONE QUARRIES.

Kilns Limestone is quarried and burned into lime at several points on the bluffs overlooking the Middle and North Forks, near Auburn. The kilns at Farnsworth's, on the Georgetown road, are large and well constructed, and have been constantly in use, manufacturing great quantities of lime, which are hauled to Auburn depot.

Caves, carbonates and mephates. In the Alabaster Cave, near Pilot Hill, hexagonal crystals of the carbonate of lime (*calcspar*) occur. In the same formation *arragonite*, (the rhombic carbonate of lime,) has been found in Tuolumne County. *Dolomite*, the magnesian carbonate of lime, is found in narrow snow-white veins, containing sulphurets, in the adjoining county of Amador; and *gypsum*, (the sulphate of lime,) occurs there in some of the mines. Fine specimens of both could doubtless be found in the quarries or caves of El Dorado.

11.—OTHER MINERALS.

Nickel. *Red nickel pyrites*, or arsenical nickel, with hornblendic gangue, from a vein in the high Sierra upon this Divide, were found by Charles Evans, in 1868. They were encased in nickeliferous iron pyrites and sulphurets of nickel.

				Besides 150 tons of copper ore.	gold $29; silver $6.		
......	....	....	....	....	At surface, $10 00, (according to Heusch.)	$4 00	....
......	....	....	....	....	Before 1868, $20 00 from 225 tons.	....	....

TABULAR EXHIBIT OF VEINS AND MINING,

ACCOMPANYING REPORT ON GEORGETOWN DIVIDE

By AMOS BOWMAN.

Mines printed in Italics below, are all on veins that have been located instrumentally; their relative position and strike being plotted on the Map.

2.—RELATIONS OF VEINS AND RESULTS OF MINING, CONTINUING SOUTHWARDS.

VEINS.	GEOLOGICAL FEATURES.	MINING AND MILLING.	YIELD & PROFIT.
[illegible]	[illegible]	[illegible]	[illegible]

The minerals occurring in the granite of this region are *graphite* (developed in workable quantities twenty miles east of the Big Trees), *sphene*, in hair-brown crystals, *garnets*, *hornblende*, etc. In Granite.

In the volcanic rocks at Mud Springs is found *pyroxene*.

For further minerals, recognized and placed, see under Gravels and Volcanic Matter, Subdivision IV; and column of Minerals in Veins, etc., in the Tabular Exhibit of Mines, § 5.

IV.—GEOLOGY.

1.—GENERALIZATIONS LOCALLY APPLICABLE TO MINING.

Comparisons

Having acquainted you with all these details, concerning mining in the domain under consideration, you will know best what to think of either by comparing them with similar developments of an established character, in California or elsewhere. In order to make such comparisons possible, however, I must be allowed a broader scope in this chapter, and, for brevity and clearness' sake, the privilege of expressing myself in part in the words coined by miners and geologists to suit the subject.

Geological section of Sierra Nev.

My notes, under this general head, along with about 500 specimens that we collected, embrace considerable material towards a geological section of the Sierra Nevada, at about the middle of their geographical extent

Position of mines

After locating the mines of the Divide as on the accompanying map, upon a large scale, the first business was to locate and map in a similar manner, but on a smaller scale, such other mines as those already considered are directly related to; and the position of both in the parent slate formation.

As these veins are acknowledged results of dynamical causes, it was necessary to go further and consider specifically their dynamical history, with that of the slates, involving their relations as observed, to the surrounding older and newer formations. Related occurrences.

The structure of the Range, and the geographical outlines of the gold-bearing slates on its western flank, etc., are, therefore, concisely stated. Slate formation.

What is said under historical geology appears broad and general enough, in part, yet it is as specific and brief as it could be to lay the foundation of certain conclusions which, it will be admitted, are as practical as they are important to the pursuit of mining in this region. Time as an element

The miner deals principally in hard knocks, or *physics* (scientifically speaking), but not entirely in physical problems. The moment he begins to read his book in its most practical part, the moment he begins to question concerning the contents of veins: "Where is the gold?" "Whither do its flakes, sheets, and chimneys extend?" "Where did it come from?" and "What minerals is it associated with?"—he leaves physics, and goes into the *chemistry* of nature. Physics and chemistry.

As it would be impossible to comprehend the phenomena of the seam diggings without some idea of vein geology in its chemical phase, I have applied the best lights extant, derived from concurrent observations of others in this field of practical science, to the subject as we find it, in section 4, below.

2.—VEIN SYSTEMS, THEIR ORIGIN AND RELATIONS.

1. STRUCTURE OF THE SIERRA NEVADA AS RELATED TO MINERAL BELTS—LEADING FEATURES.

Summits. There are three summits instead of two in the region of the head waters of the Middle and South Forks of the American.

The third summit. The great snowy belt so prominently visible from the capital, and from the valley opposite Georgetown Divide, as the dominant snow-field of the Sierra Nevada in this latitude, and of which "Tell's Mountain" is the most prominent culmination, lies in the third, or western summit. It is in this, and in the adjacent central summit, that the abundant water supplies are stored until late summer, in the form of perpetual snow, which are utilized by the California Water Company.

A snowy spur. The third or western summit starts out like the eastern summit, of which "Job's Peak" is the culminating point, in the form of a spur; yet opposite a portion of Lake Tahoe it is the highest of the three ranges. It is visible from the north end of Lake Tahoe on its eastern slope as the highest summit range, carrying the largest amount of snow anywhere visible from the Lake. It is clothed in white the summer through, and therein con-

stitutes one of the principal charms of this, the noblest of mountain lakes on the continent.

Their rock material.

The two eastern summits are granitic. The western, or Tell's Mountain range, sometimes called the Conness range, contains beds of gneiss—formed of the component materials of granite in a rudely stratified form.

Trend.

The Sierra Nevada range continues to the north, as already remarked, in two different directions—northward in the Warner range and the Cascade or the Blue (?) Mountains of Oregon; northwestwardly in the direction of the Lassen and Shasta Buttes; which are close on the eastern flank of the great area of crystalline rocks of the Trinity and Scott mountains.

Northern termination.

The continuation of the gold-bearing slate formation is seen to extend to the coast not far from the Oregon boundary, in one grand, swelling, *gentler* dome than that of the Sierra Nevada, terminating toward the north at *Bald Mountain*, 2800 feet high, in the rear of Port Orford.

"Plutonic eruptive" in origin.

Granitic Cores.—Both of these last named ranges, as well as the Sierra Nevada united at Lake Tahoe, contain cores of granite, viz: the Warner range, just west of Alkali Lake, in Surprise Valley (visited by me in 1863), and the Middle Age or Secondary coast range of the Trinity, in the divide between Cottonwood Creek, Shasta, and Trinity River (visited in 1871), and further northward into Oregon, in spots; so reported to me at Port Orford, in 1873, by an intelligent prospector and gravel miner, who had explored the entire region of the auriferous coast gravels of the coast range of Oregon. (Mr. Potts.)

Culmination of the Range.—It is to the southward of Georgetown Divide, and far south of the middle of

Fisherman's Peak.

their geographical extent, that the Sierra Nevada culminate. At a point near Owens' Lake, opposite Tulare Lake, the northerly trending mountains of the plateau of Nevada culminate in the White Mountains, and the northwesterly trending Sierra Nevada range culminate in Fisherman's Peak.*

AXES OF UPLIFT.—It will be observed that the axes, or efforts, of uplift developed the forms represented in the diagram (Fig. 29).

Combined results of two separate forces.

The northerly trends of the plateau of Nevada then had the effect to interrupt the course and deflect the uplift of the Sierra Nevada in a remarkable manner. At the point of interruption and deflection (G), the effort disclosed in the uplift of the Sierra Nevada appears to have spent its forces in attaining the highest culmination of the range.

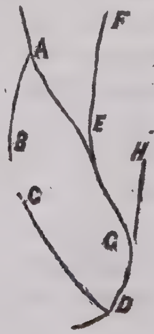


Fig. 29.—AXES OF UPLIFT.

* So named by the party that first ascended it, in honor of a fisherman, who fished for fame by naming the biggest mountain in America after himself, and locating it at Mount Whitney, six miles from Fisherman's Peak. *Vide* account of King's Ascent of Mount Whitney, supposing it to be Fisherman's Peak, by J. D. Hague, in the *Overland Monthly* of October, 1873; and of an ascent of the same mountain by W. A. Goodyear, the accidental discoverer of this error, before the California Academy of Sciences in 1873, copied in the *American Journal of Sciences*, October, 1873. See, also, King's explanation, attributing the error in the "Central Map" to local attraction, in *Mountaineering*, 1873.

A valley was formed on the California side of the range, opening northward, like those of Eel and Salinas rivers, as if it were intended to connect with the Klamath. (Note the striking identity of the axis of the Klamath and San Joaquin rivers, on the map.) Ancient rudiments of valleys.

But the Siskiyou mountains, near Weaverville, developed a spur (A, B) to seaward in sympathy with the Monterey and San Francisco arm of granite bending around from the Tejon. Thus was laid the foundation for the future very peculiar topography of the great valley of California. Their date was Tertiary.

The extensive volcanic plateau east of Shasta and Lassen Peaks, extending to Goose Lake—the Modoc country—scarcely explored before the late Modoc war, represented by the letters A, E, F, owes its origin to the manner in which the two separately-occurring forces of uplift affected that inter-montane area. The older, or north-westerly, was that of the Sierra, the date cretaceous; the newer, or northerly, that of the Cascades, the date tertiary in part, being also the date of origin of the Modoc plateau. Dates of origin, Modoc plateau.

The "Bernardino Sierra," continuing westerly from D to the Pacific coast, north of Los Angeles, are of granite. (See Blake's *Reconnaissance*, containing a geological map of the Tejon region.) It is flanked by newer sedimentary deposits, forming the coast mountains from Los Angeles to San Francisco. In a similar manner the Trinity granite mountains have their continuations to the southward in the newer sedimentary rocks forming the coast mountains extending from Trinity River to San Francisco.

The northerly trending mountains of Nevada were, according to the testimony of their fossils, uplifted in the earlier Mesozoic, or Secondary Time, he Sierra Ne-

vada later in the Cretaceous, and the coast ranges still later in the Tertiary and Post Tertiary.

2.—VEIN SYSTEMS OF THE SIERRA NEVADA—FORMATION AND STRIKE.

Relations to uplift.

GEOGRAPHICAL FOUNDATIONS.—The geography of the auriferous slates and of the associated granites, with the relative position of the axes of elevation and depression bounding them on the east and west, and the actual position of the veins, in this golden basin of the Mesozoic sea, which is now the western slope of the Sierra Nevada—instrumentally located, plotted, and presented to a vision undimmed by any fogs of hypothesis, as in the accompanying map (Fig. 34)—affords us the first definite idea of the geological relations of our famous gold mines.

Region of the gold veins.

FLEXURE AND BREAKAGE.—A zone of extreme flexure and breakage of the auriferous slates, displayed in the mother lode and its continuations, is shown by the map to be as near as can be *midway* between the axis of greatest uplift of the main or central summit, and the axis of greatest depression, which is evinced in the drainage bed of Sacramento Valley—Sacramento River itself.

Northerly and North-westerly enrichment zones.

FORKING OF VEIN SYSTEM.—On plotting the veins in their true geographical position to the mother lode *south*, and to the Nevada county and Sierra county quartz lodes *north*, of the Amador mine, we see, beside the general connection and relationship of worked veins, a forking of the vein system; which is displayed in the direction of the veins as well as in the geographical position of the vein regions, where the veins have proved rich enough to be worked.

The figures on the map designate the mines, which are similarly numbered in the printed reference list.

CORRESPONDING TO MOUNTAIN SYSTEMS.—As the Sierra Nevada range itself continues to the northward in two different directions (northward in the Warner range and Cascade Mountains of Oregon, and northwestward in the Lassen and Shasta Butte culminations), the forking of the vein-belt and predominating directions of the veins themselves, as here developed, are not remarkable, nor otherwise than might be expected. Related to plutonic eruptive causes.

METHOD OF DEDUCTION.—The diagram in the upper right hand corner was constructed by laying some tracing paper over the map, and drawing on it outlines which included all of the veins that are plotted. By cutting this out and laying it over that, it will be found to cover nearly every vein I have located, including every vein mine that could be crowded into the space, for which a United States mineral survey and patent were, up to the date of plotting, recorded in the office of the United States Surveyor-General, at San Francisco. Patented mines

RELATION OF VEINS TO THE STRIKE OF THE SLATES.—The strike of the slates is, in the main, represented by the general direction of the two formations printed black, or shaded. Both in the map, and in the small diagram in the right, the preponderance of veins keeping company with the "mother lode" in the same general direction, is made apparent. Several of the characteristic variations in direction are repeated in the little diagram, by way of suggestion as to the probable dynamical cause, or causes. The strike of the slates of course implies merely the bending and corrugation of the sediments at right angles to the lateral pressure that Northwesterly veins and seam belts

caused the principal uplift, the axis of which is seen to be parallel. That fissures were caused in the last stages of this bending is positively established; hence the particular process by which the metamorphic belts, seam belts, quartz ribbons, and the great quartz veins, like the mother lode in the strike of the slates, were formed as we see them, may be regarded partly as the *mechanical* result of different degrees of continuousness of fracture; depending upon the thickness of the slate formation, or their position relative to the main fractures, or bottom fissures.

Mechanical conditions.

AGE OF FISSURES.—The age or origin of these different systems of fissures cannot have been precisely the same. The dynamical cause of one series was not the same as that of another series. In general those parallel to each other were formed at the same time. The age was that of the related axes of uplift; so that modern fissures may be shown to have occurred in ancient rocks.

Priority of system.

The *filling* of the fissures, with a variety of minerals, such as we find in the veins, varies accordingly. Probably the time will come when the observations of miners touching the different contents of cross veins, and of geologists touching the order of uplift—the longitudinal fractures, the twists and the transverse fractures of the slates, as they were experienced in different portions of the Mesozoic basin since it became dry land—may make out clearly the priority and exact relations of the several systems.

Mother lode and her family.

The longitudinal fractures represented by the mother lode were *probably the oldest*—telling the story of the uplift of the Sierra. The twist and transverse fractures which evince a relationship either to the northerly or

northwesterly trends of the Sierra, will have to be studied probably in connection with the history of the volcanic peaks, the uplift of the Cascade Mountains, and the plateau mountains of Nevada. The mines belonging to these different systems can be tabulated from the accompanying printed list by the miner himself, and studied to suit his locality.

Examples, and Proportion of Fissures of Different Strike.—The totals below show about the proportion of veins occurring in each system described, except, perhaps, in regard to system No. 5. That might be subdivided, as it represents double the sweep of horizon of either of the other systems; including the veins intermediate between the others in course, both the (*a*) northeasterly twist and (*b*) northwesterly twist fractures. Embraced in 30 deg.

1.—*Northwesterly Fractures, or veins within* 15 *deg. of the general trend of the Sierra* (*north* 15 *deg. west to north* 45 *deg. west, average north* 30 *west*), *embracing a sweep of* 30 *deg.*—2, Potts; 5, Kelsey; 7, Arbena; 8, Grey Eagle; 15, Northern Light; 21, Salathiel; 35, Galena; 36, Sebastopol; 48, Penon Blanco; 49, Greenwood; 52, Oneida; 62, Keystone; 65, Spring Hill and Geneva; 87, Newtown; 88, S. Bright; 89, St. Lawrence; 90, Cedarberg; 114, Rocky Bend; 126, Gover; 130, Tecumseh; 136, Wisconsin; 172, Union; 194, Eureka; 201, Copp; 202, Secret Cañon; 212, El Dorado; 214, Coyote Hill; 215, Talsig; 217, Greenwood; 233, Consumnes; 243, Last Chance; 260, Murietta; 289, Empire; 292, Sulphuret; 294, Mohoney. Total, 35. Mother lode system.

2.—*Northwesterly Transverse Fractures, or veins within* 15 *deg. of a right angle to the trend of the Sierra* (*north* 45

deg. east to north 75 deg. east, average north 60 deg. east).—14, Kelly; 22, Rising Sun; 50, Spring Hill; 97, Norambaqua; 193, Eclipse; 199, Keystone; 209, Chauleur; 315, Old Pioneer. Total, 8.

Grass Valley or Virginia system.

3.—*Northerly Fractures, or veins within 15 deg. of a northerly trend (north 15 deg. west to north 15 deg. east), embracing a sweep of 30 deg.*—22, Norridgewock; 30, Spring Valley; 31, Venus; 32, Stanton & Allison; 34, Auroral Star; 44, Rough and Ready; 65, Original Amador; 73, Dry Co.; 74, Stanislaus; 80, Hancock & Tibbetts; 112, Nisbet; 115, Lone Jack; 120, Sliger; 134, Everlasting; 173, Poorman; 182, Carson; 184, Wolverine; 195, Confidence; 198, Yellow Jacket; 203, N. Confidente; 211, Shores; 233, Cosumnes; 246, Plymouth Rock; 277, Fort Yuma; 305, R. R. Hill; 319, Uncle Sam. Total, 26.

4.—*Northerly Transverse Fractures, or veins within 15 deg. of a right angle to the northerly trending axes of uplift (north 75 deg. east to south 75 east), embracing a sweep of 30 deg.*—3 and 4, Oaks, Reese & Jones; 39, Epperson; 54, State Ledge; 81, Union; 132, Tyson; 191, Keystone; 226, Wet Gulch; 238, Ophir; 298, Hancock & Watson. Total, 10.

60 degrees.

5.—*Twist Fractures, or veins running from north 15 deg. east to north 45 deg. east (30 deg.), and north 45 deg. west to north 75 deg. west (30 deg.), making in all a horizon of 60 deg., or as much as Nos. 1 and 3 together, the veins of which are neither parallel nor transverse to either of the principal axes of uplift.*—9, Schofield; 45, Eureka; 84, Enterprise; 98, N. Y. Hill; 115, Moorehouse; 124, Banghart; 128, Calaveras; 131, Bobby Burns; 138, Independent; 165, Lucan; 175, Stickle; 189, St. John; 204, Butcher Boy; 208, C. Baker; 210, Waters; 219,

Green, Walter; 233, Cosumnes; 249, Boree; 251, Crœsus; 303, Mammoth; 320, Dr. Hill. Total, 22.

(b).—THEIR CONTENTS AND PARALELLISMS.

HOW THE UPRISING OF A CONTINENT MAY HAVE SOMETHING TO DO WITH MINING.

Having shown the geographical position and relations, and the geological origin of these vein fissures in the auriferous slates, it will be in order now briefly to consider how far these, and other circumstances connected with their origin, may have had something to do with the quality or quantity of their contents.

There are four well defined parallel mineral belts, running in a northerly and southerly direction, represented in the veins of the Sierra Nevada; yielding respectively, copper, gold, base metals, and silver. Parallel N. & S. belts.

Beginning at the sea coast, and including with those of the Sierra Nevada the entire series, the order is as follows:

CORDILLERAN MINERAL BELTS.

SYSTEM.	MINERALS.	PROBABLE PERIOD OF DEPOSIT.
1. Coast range........	Quicksilver, Tin, Chromic iron......	Tertiary.
2. Sac and San Joaquin Valley	Brown coal	Tertiary and post-tertiary.
3. Sierra Nevada.		
(a) Foot hills	Copper..............................	Oldest cretaceous
(b) Mid slope	Gold mineralized by sulphur and iron, the system extending through to western Mexico..................	Cretaceous.
(c) Eastern slope	Copper and lead.....................	Cretaceous in part.
(d) Eastern slope	Silver, with very little base metal, frequently wholly or partly inclosed in volcanic rock, cutting through volcanic dykes....................	Tertiary.
4. Basin of Mexico, Arizona, Eastern Nevada, Idaho	Silver, associated with base metals..	Devonian rocks.
5. New Mexico, Utah, Western Montana	Rocky Mountains Argentiferous galena.	Mesozoic and paleazoic rocks.
6. New Mexico, Colorado, Wyoming, Montana	ditto, Gold, with base metals........	Same.

Outline of formations interesting to the miner.

The parallelism of these belts is clearly referable to the *structural features* of the country. It is related not merely to mountain ranges, but to the succeeding formations of different ages, which in those ranges were uplifted. From the Silurian to the Post-Tertiary, the gradual land-making to the westward, and the insular spots so far as recognized, all reproduce this remarkable unity of parallelism in which our gold and silver veins are concerned. In crossing the country from west to east we traverse the whole series of formations; when, by following roads parallel to the mountain ranges, we may travel continuously upon the outcrops of the same age for a thousand miles.

The great world axis of mountains and minerals.

The grand fact that the axis of the Cordillera of North and South America is continued into Asia, where it had undoubtedly a great deal to do—both in its direct continuation and in parallel uplifts—in shaping that continent; bearing upon its flanks everywhere formations producing gold or silver; and, that this is the identical axis which, passing around the world, divides it into one hemisphere nearly all land, and another nearly all water, leads the miner of the Sierra Nevada at once to the consideration of cosmical problems. And, if he could read unerringly, from the contents of the veins, the simple original cause of this line of fracture, he might contribute as effectively towards a solution of one of the great problems of space, as did the miners of Erz mountains who founded the science of geology, towards a solution of the problem of Time.

PERIODS OF DEPOSIT.

Cretaceous and tertiary.

Two periods of vein deposit—in general accompanied by the ejection of igneous rocks, affording the condi-

tions of solfataric action favorable to metalliferous deposit—are promulgated by Clarence King, to-wit: the "late Jurassic" and tertiary. The *cretaceous* age of the principal gold veins of the Sierra Nevada is definitely limited and fixed; the rocks being Jurassic (next preceding in age), and the tertiary (the next following formation), furnishing us with concentrated auriferous gravels that originated from the denudation of the veins in question.

The age of the fissures in question is always the same as the axis of uplift or fracture. See structure of the Sierra, under vein systems; and "Stratigraphy" further on. Identical with uplift.

The "Tabular Exhibit of Veins and Mining" in the last chapter, shows that one series, or half of the mother lode system of veins, is older than the other. [See Pine Tree.] And under "Mineral Contents of Veins" further on, will be found reasons for the conclusion, that the companion talcose veins and seam belts belonging to the same general system are newer than the mother lode. Two ages in one system.

The copper zone of the foot-hills is older than the great central vein system of the western slope, or occurs at least in older (triassic) rocks. Oldest.

The *tertiary age* of the veins on the eastern slope of the Sierra is based on the assumption that the accompanying eruptive rocks are tertiary. It is not distinctly stated whether their synchronous occurrence with, or relations to the pliocene lavas of the Sierra, or any other determined formation, have ever been made out. Richthofen's determinations of the age of the "propyllites" and "rhyolites" have been shown by Dr. Blake to be as hypothetical as the new names he gives these The northern strike or silver system.

rocks are unnecessary and confusing. They are evidently not newer than the tertiary; nor can they be older than the cretaceous, to which period those fractures on the eastern slope that are related to the main or northwesterly axis of the Sierra must be referred. This embraces several of the base metal mines, the Santa Maria and Exchequer, in the "Tabular Exhibit."

Newest—why tertiary

The *northerly* trending axes and vein fissures of the Sierra Nevada generally, whether on the eastern or western slope, would appear to be newer than the northwesterly trends: 1. From the fact that the northerly trending uplifts, of which the Cascade range in Oregon is the continuation, have been shown by Professor Le Conte to belong to the tertiary. The Cascades at the Dalles are miocene. 2. That they intersect dykes which are probably tertiary.

Transverse, fractures, cretaceous, &c.

The age of the *transverse* fissures of axial system No. 2 may be the same as that of No. 1—cretaceous—for the reason that the uplift of the Sierra was uneven; being 15,000 at Fisherman's Peak, and only 6,000 at Beckworth's Pass. And a similar state of things might be referred to in connection with the northerly transverse fractures, No. 4. But better evidence is desirable in regard to the age of both these and the *twist* fractures, No. 5. The mineral contents and intersections with other systems, or with dykes, may furnish the means of determining them.

FISSURE SYSTEMS, AS TYPIFIED BY DISTRICTS, OR ORIGIN.

Grouping according to results.

I need not repeat here the geological characteristics of mines presented in the Tabular Exhibit; but an ar-

rangement according to the contents and yield of mines typified by well known districts, will help out systematization by comparison. We may designate the vein systems according to districts, as follows:

1. The Mother Lode system.
   (*a*) In the southern counties;
   (*b*) At Grass Valley;
   (*c*) Accompanying talcose veins.
2. The Eureka or Sierra Buttes system.
3. The Base Metal systems,
   (*a*) Of the western slope;
   (*b*) Of the eastern slope.
4. The Comstock Lode system;

Classifying the subordinate transverse and related twist fractures as belonging to the main system, in connection with which concurrent testimony may prove that they arose.

Or, as related to strike *alone*, regardlessly of age or contents—pointing to identical continued, or repeated, dynamical causes, thus: **Grouping according to causes.**

1. Northwesterly strike: (1.) Mother Lode System—(a) in the southern counties; (b) at Grass Valley; (c) accompanying talcose series. (2.) Base Metal System of the Foot Hills.

2. Western slope, cross fractures generally: Eureka and Sierra Buttes Systems.

3. Northerly strike: (a) Comstock Lode System; (b) on Western slope; (c) Eastern slope, Base Metal.

(4).—POINTS APPLYING TO GEORGETOWN DIVIDE.

While nearly everything that has been said or tabulated, relating to vein systems or mining not upon

Georgetown Divide thus far, finds its application on Georgetown Divide, as represented in the preceding detailed description—either as a counterpart or a case of contrast—there are several points to which your attention ought to be specially directed :

True mother lode system.

1. The descriptions of the Quartz Hill, St. Lawrence, Taylor, and Sliger veins, compared with those of the Mother Lode and Grass Valley veins of a northerly or northwesterly strike, show conclusively that the great *fissure zone* of the Sierra is here represented in all its geological characteristics, accompanied by wealth in gold.

What are the seam diggings

2. The *related talcose* vein series on Georgetown Divide accompanies the Mother Lode through the southern mines. The phenomena of the seam diggings are associated, however, not with the Mother Lode alone, but also other veins of the Mother Lode system. They belong in part at least to a later period than the Mother Lode system, and are due to chemical conditions described under section 4, "Mineral Contents of Veins," further on.

Pay chimneys in true fissure veins

3. *Lenticular masses*, or chimneys of quartz often having a feather edge are characteristic of the best mines worked on either slope of the Sierra. In fissure veins the fissure always continues; and both the quartz and the pay are as likely to be repeated in adjacent chimneys prolifically as to yield, within certain limits, as though there were no ore bodies nor chimneys of quartz, and the pay were only found in sheets resembling veins of coal. These things are in the nature of fissure vein deposits. While spaces of 1,000 feet, however, upon the Mother Lode, or any other vein, may be found rich, or in the form of chimneys or

lenticular masses, the extensions beyond are more likely than not to be poor.

4. The tabular exhibit affords abundant proof of the general rule that the quartz *widens* and also *increases in richness* in depth. There are exceptions, but the results of experiences cited from so many localities, can not be resisted. In a large majority of instances the pay chimneys dip north. **Character of veins in depth.**

5. Parallel veins adjacent to rich deposits are usually barren, even if uniting into one vein in depth. Instances where veins of the character of the seam diggings unite with some main quartz vein adjacent in depth, are not infrequent in the tabular exhibit. The importance of any given belt as an ore channel in depth, can only be inferred from these concomitant indications, taken along with the yield of the seams. Nor is the quantity of quartz in place conclusive as against the existence of gold deposits belonging to what might once have been a well defined vein. See various talcose slate and seam diggings in the tabular exhibit and section 4 "Contents of Veins." **Double veins and decomposition belts.**

3.—THE COUNTRY ROCK, OR MATRIX.

1. *Geographical Outlines* and relations of the Auriferous Slates—Published Sources—Relations to Ancient, Middle Age and Modern Rocks—Associated Granites.
2. *Historical Position* of the Slates.
3. *Stratigraphy* of the Sierra—Scenic Features—Uniformity of Strike—Evidence of Folding—Position of Great Gold Vein Region—Limestone Masses—Stratigraphic Details.
4. *Lithology* and Distribution of Rocks in Detail—General Lithological Features—Metamorphism—Lithol Details.
5. *Granite Regions.*

(1).—GEOGRAPHICAL OUTLINES AND RELATIONS

OF THE AURIFEROUS SLATE FORMATION OF THE WESTERN SLOPE OF THE SIERRA NEVADA.

Fundimental to the mining industry.

I have now pointed out the position and the relations of all the notable veins and seam-belts; and delineated the character of the deposits developed by mining. The conditions under which the miner operates in seeking gold in veins would be very imperfectly stated without some account of the country rock, in which these veins are distributed, and in which they *apparently originated.* The geography and relations to neighboring formations, of the world-famed auriferous slates of the Sierra Nevada, should have been determined, or become the property of the public, in outline at least, a great many years ago.*

HISTORICAL POSITION OF THE SLATES: THREE AGES.

Jurassic to carboniferous.

While the slates in the longitudinally central or vein-bearing portions of the Sierra are accompanied by Jurassic fossils, as in Mariposa County, the silicious strata developed near the summit, as at Redding Soda Springs, have a relationship in strike to the older triassic and carboniferous rocks found fossiliferous and also gold-bearing in Plumas County.

* PUBLISHED SOURCES.—P. T. Tyson, in a report to the Secretary of War in 1849, described the principal lithological characteristics and the physical relief of the Sierra Nevada. Wm. P. Blake and others, in the Pacific Railroad reports dating down to 1862, and the members of the Geological Survey of California since 1860, besides various travelers and contributors to the United States records of the Bureau of Mining Statistics, and to the journals of the day, have contributed to the general knowledge on the subject. The State of California has appropriated $250,000 for the publication of such information lying at the foundation of her peculiar industry.

Other fossils of the period next preceding the Jurassic, have been found in the form of impressions on the surface of the slates, at several localities in the region embraced in the accompanying map.

I refer to the triassic fossils found at Coloma, on Placerville divide, and contributed by John Conness to Dr. Trask, (goniatites); also fossils found at a point two miles west of Spanish Flat, on Georgetown divide, by Gorham Blake; (viz: of a cephalapod which could not be distinguished from the belemnite found on the Mariposa estate, and a goniatite, found also in the Humboldt mountains of Nevada.) Whitney, in volume 1, Geology of California, sets this formation down as corresponding to the upper Trias beds of Hallstädt, and Saint Cassian, in the Alps. Triassic.

Near the western base of the Sierra, in Butte County, there are still older rocks than the Triassic. I refer to those containing the carboniferous fossils found at Pence's ranch, near the foot of Table Mountain. Not far from the summit of the Sierra, in Plumas County, there are found fossiliferous rocks of the same remote age. Carboniferous.

If the strike of the slates then, associated with localities definitely located as to their geological position, by fossils, may be taken as an index of the age of the rocks at the base and summit of the range, respectively, on Georgetown divide, it would appear that there are *older rocks than the central zone of gold-bearing slates, both at the base and the summit*—the eastern and western margins of the ancient basin in which were formed the auriferous slates of the Sierra Nevada. Basin of ancient longitudinal subsidence.

The older rocks of the Redding Soda Springs, at the head of Forest Hill divide, are strikingly different in Oldest rocks in the Sierra.

appearance from the slates occupying the greater portion of the slope of the Sierra westward of them. They are white, highly silicious, and crystalline in their character. These characteristics are observable in a less marked degree on Georgetown divide, where thinly bedded series of the same character of rocks are found in the Tell's Mountain range, interstratified with gneissoid rocks, and mica slates, showing a close relationship in their lithological character to the granites themselves. J. E. Clayton confirms me in having observed a similar series of (probably ancient) crystalline rocks, near the summit of the Sierra, on its western slope; and states that their lithological character suggests to him their possible identity with a series of rocks found by him across the mountains, on the Nevada side, at Silver Peak; containing an abundance of fossils of Silurian age.

Pilot Hill, situated near the edge of the granites to the west of the auriferous slate formation, is composed of crystalline rock, differing considerably from anything found anywhere near the center of the geological basin of slates.

Concerning the geological age of these rocks of the western slope, we have, then, *three points established:*

Carboniferous rims

1. That they are situated in a *granitic basin*, the rim of which, on the east and west sides, is as old as the carboniferous period; its lithological relations to the devonian and silurian rocks of Nevada never having been followed out. The rocks at both the western and eastern rim are crystalline, and different in character from those in the center.

Coal plant and reptilian ages.

2. That in it were deposited sediments which formed slate rocks of the *three grand, ancient subdivisions* of

Geology, viz: the Carboniferous, the Triassic, and the Jurassic, distributed as follows:

(a) Of the Carboniferous period, the outcrops of which have been identified both near the eastern and western rims of the basin.

(b) Of the main body of auriferous slates, composed of two periods, viz: the Triassic and Jurassic; the geographical distribution of which, from the evidence of the fossils found, is mixed. So that we must look for the present to lithology as our only guide to their historical position. (See under Lithology.) Two folded together.

(c) The localities, so far as determined, belonging to the newest period (the Jurassic), are situated principally near the center of the basin. And the oldest of the two named formations, as developed by means of fossiliferous evidence found on Georgetown Divide and in Plumas County, at points well toward the eastern rim, and also well toward the western rim (at Coloma); underlies the main body of the Jurassic slates. Newest near mid slope.

Under Physical Geography I have described the undulations that are everywhere associated with higher degrees of metamorphism.

Under Stratigraphy will be found the key to the foldings of the slates which took place in the center and throughout the whole width of the basin. Related matter.

And under Lithology will be found facts furnishing our only remaining clue, in the absence of thorough paleontological research, to further the details concerning the age of auriferous rocks.

Descriptions of the fossils referred to will be found in Paleontology, vols. 1 and 2 of the Geological Survey, and in connection with Blake's and Newberry's geological reports in the U. S. R. R. explorations.

(3.)—STRATIGRAPHY OF THE SIERRA.

From ocean bed to mountain dome.

That the slate-forming muds were in general deposited in pretty deep water, throughout a long period of time, we have good reason to believe, from their consistency, and from their probable thickness. No careful geological measurement of the thickness in feet, has ever been attempted. Yet it would seem that in the extreme simplicity and regularity of the bedding of the slates as indicated at the surface, along the entire western slope of the range, we should find it not difficult to hit upon an explanation of the precise *method of granitic uplift* whereby the off-shore strata of mud became shaped into a dome of such unparalleled sublimity as that witnessed in a profile section across the Sierra Nevada. This dome presents to our view an unbroken and almost perfect arc, over a base of 70 miles, having an altitude, at the head of Georgetown Divide, of 8,000 to 10,000 feet. (See Stratigraphy.)

Vertical dip unconformable.

DIP.—A stratigraphical section of the western slope of the Sierra, as laid down in profile, shows the position of the gold-bearing slates overlying the "primitive" or palæozoic gneiss and crystalline schists of the summit belt in the great dome of the Sierra, to be very far from regular, or conformable to the remarkable vertical dip which is the principal scenic and mining feature of the slates toward the foot-hills.

Low eastern and western dips.

Between Tell's mountain range and the rich vein region of the mother lode and its continuation northward, there are on Placerville Divide many square miles—hundreds, I might have said—of gneissoid micaceous slates, lying nearly horizontal, or even dipping to the westward along the southern margin of the ac-

companying map—on the road from Placerville to Virginia City.

This is a noteworthy exception to what has hitherto been regarded as the rule, that of an unvarying easterly dip at a steep angle.

Folding unmistakeable

We find, then, in the stratigraphy of the auriferous slates, not a continuous vast bedding of such astounding thickness as would be implied in a conformable stratification with the dip, from base to summit; but every evidence of *folding*, like the folding which took place in the Alleghanies, and has been demonstrated by Rogers; while at the eastern end, the geological base of the series, we find the slates very plainly and very naturally superimposed upon silicious and crystalline schists, the gneissoid strata referred to; and these in turn upon the foundation rock of identical mineralogical constituency, the granitic core of the Sierra Nevada.

Local details of strike and dip.

Where the dip of the slates in the basin is steep, the angle nevertheless varies greatly. Sometimes it is to the east, and one quarter of a mile off it is to the west again. The angle of easterly dip varies from 40 to 90 degrees. In all probability, zones of low angles and high angles of dip might be traced for some distance in the line of the strike of the slates.

Prevailing dip.

In making a cross section, all that can be said is that the *prevailing* dip is to the east; which is equivalent to saying that the eastern end of the slope is lifted, and at the same time the apex of each anticlinal is shoved away, perhaps, from the main axis of the Sierra.

Not lamination from pressure.

At Greenwood, and numerous other localities occur sandstones and conglomerates in various stages of metamorphism, dipping conformable with the slates.

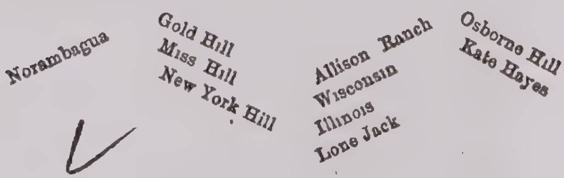
This fact shows conclusively that the lamination of the slate is actual bedding, and not to be ascribed to cleaveage from lateral pressure.

Dip in cañons and mines

It has been remarked that the dip at the bottom of El Dorado Cañon on Forrest Hill Divide, 1,200 feet deep, is steeper at the bottom than at the top. Curves of this character are universal in all the cañons in either slope, and are observable in cuts, shafts, and ravines in the mining region, within distances apart of 10 to 50 feet vertical; and are quite as perceptible as in the cañons, 1,000 feet deep. The convexity of the curve in these is frequently towards the west, however, as well as toward the east, as at the Doncaster mine. Such convexity furnishes us with a *clue* for the study of stratigraphic details, inasmuch as the western convexity must necessarily belong to the western half of an anticlinal, and the eastern convexity must, in like manner, belong to the eastern half of an anticlinal.

Example north of Georgetown

At GRASS VALLEY, Nevada County, Professor Silliman recognises a *synclinal*, or *geological valley*, as follows, in the dip and strike of the veins mentioned, entirely conformably to that of the slates in general, occurring between the New York Hill Vein and the Allison Ranch vein; and a *saddle* or *anticlinal* in the valley between the veins of Cincinnati Hill and Massachusetts Hill, which is repeated below and to the westward of these claims by the elevation of the syenitic mass in which the Norambagua occurs:



TABULAR EXHIBIT OF VEINS AND MINING,

ACCOMPANYING REPORT ON GEORGETOWN DIVIDE

By AMOS BOWMAN.

Mines printed in Italics below, are all on veins that have been located instrumentally; their relative position and strike being plotted on the Map.

RELATIONS OF VEINS AND RESULTS OF MINING, CONTINUING NORTHWARDS

VEINS.	GEOLOGICAL FEATURES.	MINING AND MILLING.	YIELD & PROFIT.
Placer County.			
[illegible]	[illegible]	[illegible]	[illegible]
Nevada County.			
[illegible]	[illegible]	[illegible]	[illegible]
Sierra County.			
[illegible]	[illegible]	[illegible]	[illegible]
Yuba County.			
[illegible]	[illegible]	[illegible]	[illegible]
Plumas County.			
[illegible]	[illegible]	[illegible]	[illegible]

4.—RELATIONS OF VEINS AND RESULTS OF MINING AT THE EASTERN BASE OF THE UPLIFTED GOLD BEARING SLATE FORMATION.

[illegible]	[illegible]	[illegible]	[illegible]
Alpine County.			
[illegible]	[illegible]	[illegible]	[illegible]
Mono County.			
[illegible]	[illegible]	[illegible]	[illegible]
Inyo County.			
[illegible]	[illegible]	[illegible]	[illegible]

The course and dip of the Grass Valley veins, he further says, are conformable with the rocks, and "the streams have in general excavated their twenty valleys in a like conformable manner."

At the PRINCETON MINE, Mariposa County, which is situated in the center of Bear Valley, Mariposa County—a valley trending northwest and southeast, parallel to the Sierra—Prof. Blake observed a stratigraphic section of the auriferous slates at right angles to the crest of the Sierra, namely, from the Bear Creek Mountains on the west to the Mount Bullion range on the east; and recognized a plication, or folding, in the form of a simple anticlinal. At the vein, which is conformable in strike and dip, the slates are soft and finely laminated, light colored or drab at the surface and black in depth, with numerous intercalations of sandy layers, passing into coarse grits, sandstones or conglomerates. In both of the bounding ridges there are only heavy metamorphic conglomerates. Magnesian rocks accompany the vein, in the region of the soft shales of the valley. Example south of Georgetown.

In nearly all the high ridges on Georgetown Divide, enumerated as trending parallel to the Sierra, there is observed a high degree of *silicious* metamorphism, accompanied either by porphyritic or crystalline rocks; while the intermediate spaces consist of soft light or dark shales, showing zones of *basic* metamorphism, and containing hydrous-magnesian minerals. Silicious and basic metamorphism.

RELATION OF GRANITIC AREAS.

Between Pilot Hill and the Little South Fork of the Middle Fork, there are few out-crops of granite.

East of that point all is granite; slate is the exception.

Junction of slates and granites, west.

The American River, between Cape Horn, above Colfax, and Folsom, runs in general *along the strike* of the slates. It follows the line of their strike for a mile or two, and then, turning abruptly, crosses the strike at right angles, or in the direction of the slope of the Sierra, for a few hundred yards; only to resume afresh its former course in the strike of slates, in the whole of the next long reach of the river. This is characteristic of that portion of the American River for a distance of 35 or 40 miles by the river. At Wild Goose, the American follows this line of strike near the junction of the slates with the granite; affording excellent opportunity for a stratigraphic section at the base of the Sierra, or the *western rim* of our auriferous basin. One mile from Auburn, just before coming to Smith's house, on the American River, on the old road to Coloma, occurs a dyke of fine grained syenite. Trappean intrusions join the granite abruptly, and quartz is abundant in this region.

East.

For a similar section of the slates near the *eastern rim* of the basin, Tell's Mountain range offers a good exposure. Here becomes evident the grand fact that the slates near the summit are thinly bedded, and are in large part carried away by denudation; for we can see to what extent denudation has left the granite exposed. The dip at Tell's Mountain is at a very low angle to the east.

South.

On Placerville Divide the granite of the summit reaches *far down* the slope; and the South Fork of the American appears to have followed for some distance near the northern rim of a promontory of this rock.

The dip of the slates along the South Fork of the American, adjacent to the granite outcrop, is, accordingly, changed to all angles, and nearly all points of the compass, from west to south and east. In the Slate Mountain range, just across the river on Georgetown Divide, the dip is southerly and westerly. For ten miles on the Placerville road, above Brockliss' Bridge, the dip is at a low angle *to the west.*

SCENIC FEATURES—UNIFORMITY OF STRIKE.

Where the slates are not associated with granitic outcrops there is a *remarkable regularity in their strike.* Over a section nearly fifty miles east and west in a straight line, there occurs no other geological feature so prominent to the observer. The direction, of course, varies in places, but only slightly. I have found nothing anywhere near the central or western portions of the slate basin indicative of a cataclysm such as the "immense edgewise longitudinal thrust which the mass of the Sierra must have undergone, by which vast bodies of strata, once continuous for hundreds of miles, have been torn asunder, portions engulfed, and the remainder twisted so as to lie at all angles with regard to the original direction of the mass, but not so far removed as to leave any doubts of their having once been parts of the same continuous formation," imagined by Professor Whitney, in volume 1, Geology of California: [See under Limestone, below.] Supposed cataclysm.

The most prominent scenic features of the foot hill region are the *long lines of slates* standing on end like gravestones, continuously in the same general line of strike from Calaveras to Butte County. The general parallelism and perfect regularity of strike is, as re- Significant gravestone slate

marked, the grand feature of the auriferous slate formation, over the entire western slope. The local variation of strike in the Slate Mountain range, (accounted for,) is the only exception I have seen in about ten thousand square miles of the formation.

Unbroken plateau slope.

William P. Blake, in his visit to the mining region, in 1864, recognized another of the characteristic physical features of the western slope of the Sierra, and correctly described the enormous erosions in the auriferous slates as having taken place in "one *unbroken* plateau or slope."

Birdseye view.

Whatever may have been the method of tilting the slates underwent, their plateau-slope character, as shown in one *grandly regular*, easy line of profile from base to summit, on which the undulations described under Physical Geology are insignificant, is a feature anywhere noticeable to the geological observer. But it is nowhere else so unmistakably recognized, and so striking to the eye, as from the dome of the State Capitol, at Sacramento. The parallel lines of this slope are, from that point, seen to lie level behind one another like the lines of a level plain. [See fig. 2 page 9.]

Corroborative testimony.

Professor Blake clearly testifies to the same facts, viz., that the auriferous slates trend in a northwesterly course "with great regularity, and without any abrupt local plications or disturbances of the beds." "The plications, where they exist, are upon a magnificent scale, and very regular."—(Geological Reconnoissance of California.)

Ancient river flats.

The same idea of plateau character connected with the slate formation has frequently suggested itself to me from local observation of the bed-rock flats associated with the gravel courses of ancient rivers.

DYNAMICAL CAUSES.

I need not enter into any particulars concerning the forces which caused the original foldings of the slates, the formation of this plateau or gradual slope, nor the character of the sediments which made folding and plateau formation possible, and unavoidable. For the operation of the same ever-enduring, simple physical forces, see Dana's Geology. Cosmical problem

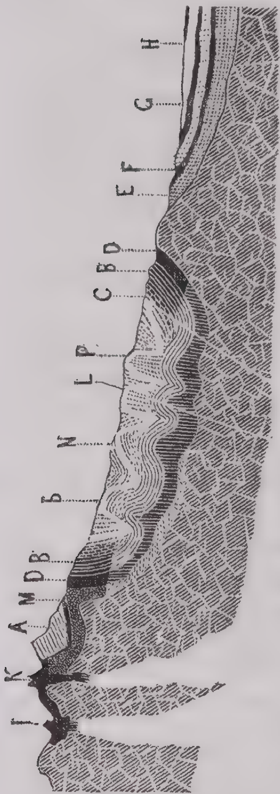
EVIDENCES OF FOLDING.

The occasional *parallel granite belts* or dykes, intermediate between the summit and base of the Sierra on other divides, and on this one especially near the eastern and western rims, show conclusively that whatever may have been the origin of the granite, (whether it was Plutonic metamorphism or eruptive ejection,) the slates at midslope must have been extensively folded by the operation of the same agencies which enabled the granites to protrude. Plutonic pores

If it was eruptive ejection, then the slates were folded and lifted along with them. If it was Plutonic metamorphism of deeper seated strata, the strata were corrugated, and the lower metamorphized ones bent upward, and afterwards denuded off at the surface, and so exposed.

In neither case is the *rationale* of the slates at midslope altered. *The thickness of the slates*, however, might be differently concluded upon. On the latter hypothesis, the frequent exposure of granites in parallel belts conformable to the slate, as on the Grass Valley divide, would imply thin bedding. In the tabulur exhibit of mines, the probable limits of thickness are referred to as from one and a half, to three miles, vertical. That it Sediment of an ancient valley

Fig. 30.—STRATIGRAPHIC SECTION.



A—Tell's Mountain; nearly horizontal slates of Tell's Mountain and Mount Dana; probably as old as the carboniferous.

BB—Robb's Mountain; Triassic of Colfax and of Plumas County.

b—Sand Mountain.

C—Pilot Hill; Triassic of Coloma; Copper veins.

DD—Carboniferous; limestones of Plumas Co. and Pilot Hill; limestones of Butte Co.

E—Cretaceous; marine Folsom.

F—Tertiary, accompanied by coal deposits; partially marine; parti'ly like *H*

G—Post tertiary clays, adobes, loams and gravel.

H—Peat of the Tule formation, intercalated by fresh or brackish water; lacustrine deposits, like *G*, forming the basin of Sacramento River.

J—Granite, underlying all.

IK—Volcanic craters and overflows at the Summit, damming the northern end of Lake Tahoe, and filling up or capping all the gravel-filled cañons of the tertiary period; being of the same age as the line of demarcation *FG*.

L—Jurassic of Spanish Flat, Kelsey and Spanish Dry Diggings Range; position of the Georgetown seam belts.

M—Gneiss of Tell's Mountain and Brockliss' Bridge; probably older than the carboniferous rocks.

N—Grey Eagle Hill; horizontal slates flanking the granite and gneiss country on Placerville Divide, adjacent to Georgetown Divide.

P—Goat Mountain and Greenwood trend.

I—Mount Pluto; volcanic peak at the north end of Lake Tahoe.

K—Twin peaks head of Blackwood Valley, Lake Tahoe.

could have been more, is not impossible; though the probabilities would be against that supposition, until the fact could be demonstrated by stratigraphical evidence. In prosecuting this inquiry, it should not be forgotten that the midslope region was in the Triassic and Jurassic periods the center of a valley; and the position of an axis of depression like that of Sacramento Valley, having older rocks as elsewhere demonstrated, on the east and west.

The folding, and general stratigraphic character of the slates of the region, according to these facts, is represented by the foregoing section across the Sierra Nevada.

The granites of the summit and of Folsom were the *abutments of the arch;* and the sediments of the region, which were originally sinking at mid slope, forming a geological valley, must have begun to arch up and fold the moment the abutments began to be brought nearer together.

POSITION OF THE PAYING VEIN REGION, OR MOTHER LODE, ETC.

The question arises where are situated the oldest rocks of the mining region? Are the veins, which most concern us, in the older or newer rocks; at the top or bottom of the Jurassic series?

Top of the series.

From the above section and from the remarks made under historical geology, it will appear that their position is most probably in the *newer rocks,* or at the top of the series. The oldest rocks lie near the base, and near the summit, of the Sierra; those inclosing the principal gold veins are near mid-slope.

LIMESTONE MASSES.

Lenticular bodies

Neither on the Yuba nor in the basin of the American, is there anything like a continuous limestone formation. Limestone occurs in small lenticular masses of white and crystalline rock, conformably to the dip and strike of the slates. A large cave exists in a body of this character, at "Alabaster Cave," near Pilot Hill. On the road from Auburn to Georgetown, limestone has been quarried, and manufactured into lime extensively for many years. Dolomite also occurs in

Amador County, in narrow snow-white veins, traversing talcose and chloritic rocks, and bearing coarse free gold.

A zone of limestone country, several miles wide, and many miles in length, occurs further south in Tuolumne and Stanislaus river basins; and limestone is again found in Butte County, where it is fossiliferous, and of carboniferous age.

Genuine bedded limestone, carboniferous

In the limestone region of Tuolumne and Calaveras counties, this rock is conformable to a parallel with the slates. Like the slates, it is generally vertical in its planes of structure, which are planes of bedding. At Abbey's Ferry limestone is found in connection with mica slate, and granite. Though to some extent metamorphic, it is more regularly stratified than the limestones of the Tejon, where the metamorphic action was more intense. That of Tuolumne has many blue layers and veins, all trending with the strike of the slates. [Blake's Recon.]

Undetermined age

Interrupted limestone series

The limestone outcrops near the Coloma and Auburn limekilns on Georgetown road, and at Yankee Jims, Colfax, on Wolf Creek below Grass Valley; also near Black's Bridge, six or seven miles above Nevada City; and at Emory's crossing, on the Midde Yuba, continuing thence northward for thirty miles, and crossing Feather river below Strawberry Valley on the Marysville and Laporte road, (being claimed as a quarry by Butts and Diamond, near Camptonville, etc.,) are examples of geographical distribution.

A northerly and a northwesterly trend

These deposits are obviously not all of one continuous formation, nor the result of any reasonably imaginable dislocation. The most that can be said of them is that there is possibly a zone of interrupted

limestone intercalations continuing toward the north, in a line parallel to the northerly trend of the course of Sierra at the head of the American and Yuba basins. There is no reason indeed, why local masses of limestone should not have been forming throughout all of the three periods represented by the auriferous slates.

There is near Ringgold a disconnected mass of limestone about one mile square, the beds striking E. of N. and dipping E. 50°, which is considered by Whitney to be in the same strike of the slates as that at Indian Diggings, eighteen miles southeast of Ringgold, at Cave Valley, at the limekilns on Wolf Creek, Nevada County, and that of the limestones of Pences ranch, Butte County; having accordingly "the position that one connected group should hold." But there is no connected group. He recognizes another belt running nearly parallel to the last named, "situated about ten miles further west;" crossing the south fork of the American at Salmon Falls, and connecting with a similar deposit at Clarksville, eight miles southeast of Folsom. Guesses at connections

STRATIGRAPHIC DETAILS.

The granite belt of the foot hills lies west of Auburn, and west of Coloma; extending to the edge of the valley as far as any rock is visible.

This belt is, geologically, the most important erupted axis of the entire region. As remarked, it is the first rock met with on leaving the plains. It continues north, as represented in the general vein map, in the strike of the slates, west of the Grass Valley series.*

At Logtown, seven miles southwest of Placerville, several gold-bearing veins occur in granite. Four of

*Compare with N. & N. W. axes, Fig. 29, p. 108.

these—the Empire, Pocahontas, Excelsior, and El Dorado, strike northwest and southeast, parallel with the Mother Lode series.

Grizly Flat, sixteen miles east-southeast from Placerville, has veins also in granite, containing sulphurets of lead and zinc.

The strike of the slates at Placerville is N., 21° W.; elsewhere from N. 20° to N. 30° W. At Sarahsville, on Forrest Hill divide, the strike is N 5° to 10° W.

The strike of the slates further north than Georgetown, as at Grass Valley, becomes more nearly north and south.

The hills along the south fork of the American, at Coloma, consist of low projecting points of granite.

4.—LITHOLOGY AND DISTRIBUTION OF ROCKS IN DETAIL.

Specimens. I collected for notice under this head about five hundred specimens of rock and vein material. The former are important, as showing the details of a geological section across the entire width of the auriferous slates.

They are all located by approximate measurements connected with fixed points upon the map.

The latter represent, beside the vein material, the peculiarities of the country rock in which different mines, at nearly all points on the divide are situated. They consist of ores, minerals, gangs, and adjacent country rock associated with veins and seams, accompanying the sections and descriptions given under III., Mining.*

* See note foot of page —.

GENERAL LITHOLOGICAL FEATURES.

With the exception of granites and the erupted trachytes, all the rocks on the divide fall under the heads of *fragmentary* and *metamorphic*.

Clay slates, talcose slates, and sometimes mica slates, alternate in bands running with the general strike of the slates. Rocks classified and grouped

METAMORPHISM.

There is a *low degree* of metamorphism near the center of the slope. The slates are generally light colored, and thinly laminated. For many miles where the color is light, the slates have apparently changed but very little from the original sediment. Except in the matter of consolidation, the same holds true over half the country.

The *more highly* metamorphosed portions are adjacent to the vein or seam systems; or to ridges of green stone. The latter is itself metamorphic, and sometimes crystallized out into definite diorite; sometimes crypto crystalline, as aphanite. In seams and ridges

These "*dykes*" are considered by many geologists and others as intrusive, consequently as belonging to a later period of eruption through fissures. I have not hesitated in expressing my opinion that they are metamorphic, as I have seen repeated evidences of their being formed in much the same manner, and by the same causes, as the veins themselves, and the gouge associated with the veins. The traps and diorites are found in a thousand places in all stages of transition, from indisputable slate to indisputable trap or diorite which cannot be distinguished lithologically from the "massive" or "eruptive" rock. The specimens I have collected will themselves testify to this fact. Eruptive or metamorphic

Occurrence. The "dykes" occur in parallel *lenses* from 6 to 10 and 20 feet wide. They are repeated irregularly, sometimes every few hundred yards apart; generally associated with ridges.

MINERAL BELTS.

Both the slates and greenstones are traversed by quartz veins which are full of crystallized iron pyrites, associated with gold. In some metamorphic zones the country rock changes into serpentine, or serpentinoid rock; or into "soapstone," a rock of soapy feel, more or less approaching the mineral steatite.

The slates of certain zones, especially where there is basic metamorphism, decompose very easily at the surface, to a depth of 20 and even 150 feet, so that they can be readily excavated with a pick, or with the hydraulic pipe.

LITHOLOGICAL DETAILS.

Sandstones and conglomerates. The character of the slates is in all the gradations from roofing slate to sandstone and conglomerate. The latter is sometimes so highly metamorphosed as to be barely recognizable with certainty. Masses of sandstone occur in various stages of metamorphism; patches retaining almost entirely their original condition.

Locations of varities of slate. On Irish Creek the slates are like roofing slate. At Kelsey's and at Georgetown they are more talcose and magnesian. Generally around Georgetown they are very slightly metamorphosed, and either light colored or black and compact. West of Greenwood and east of Forney's there is a great deal of metamorphism. At Sarahsville on Forrest Hill Divide the slates are light colored and talcose. In the neighborhood of Auburn and northward, there are hard clay slates.

Several of the most noteworthy localities of metamorphism into serpentine are at Bald Hill on Georgetown Divide and Brimstone Plains on the road from Sarahsville (on Forrest Hill Divide) to Independence. This serpentine "forms the largest mass of the kind in the State," being lithologically, according to Prof. Blake, identical with that found at Fort Point, San Francisco. Abundance like that of S F

Masses of serpentine also occur in the midst of other metamorphic rocks near the junction of the slates with the granite, north of Auburn; and associated with the seam diggings at numerous points on the Divide. Near granite or seam belts

The Granite of the foot-hill belt between Auburn and Sacramento is itself traversed by feldspathic or granitic veins. It weathers in large, round blocks, looking like great boulders, scattered over the surface. Granite dykes in granite

On Placerville Divide the granite sets in opposite Coloma, cutting off there, as well as on Georgetown Divide the basin of the slates from the Valley. Boundaries.

Toward the eastward the granite again sets in between Sportsman's Hall and Brockliss' Bridge on Placerville Divide, and on the east slope of Mount Robb on Georgetown Divide.

In the basin of the Rubicon, at the head of Georgetown Divide, the granite is remarkable on account of showing immense *cleavage* lines, which have been cut into by streams, and followed for a short distance only before leaving them again to seek their nearest course by gravitation to the river. In overlooking this country from a high mountain, it is almost impossible to recognize, or with the eye to follow, the course of the streams in the valleys and mountain sides, owing to the abundant repetition of partially eroded cleavage courses, like little Yosemite Valleys. Little Yosemites.

4.—MINERAL CONTENTS OF VEINS.

1. First principles concerning Ore Channels.
2. Distribution of Gold.
3. Solution and precipitation of Gold, Iron, and Silver in Nature.
4. Processes of Chemical Concentration.
5. Mechanical concomitants.
6. The Mineralizers.
7. Philosophy of Chemical Action and aggregate results.
8. Mineralogical contents and Paragenesis.
9. Age of Gold-bearing Formations Predicated upon the origin of Gold.
10. Age of Great Central Vein System of the Slates.

1.—FIRST PRINCIPLES CONCERNING ORE CHANNELS.

Illustrated by comparison.—When the light first dawned upon the placer miner, that there were ancient rivers in the hills richer than those of "'49," he was not slow to discover or take advantage of the first principles of hydraulic mining. There was surely a channel; that channel had a definite (though winding) course; it had a deep gutter; and it had a rim, or rim rock, on either side.

Luck in placer mining. The man who now expects to pursue profitably the business of hydraulic mining without regarding these first principles, would be deemed a strange phenomenon if he did not, sooner or latter, outlive his luck.

What we know about quartz mining. We have found in these slates great gold deposits, such as the world never knew before California "came out." We have formed an idea of the outlines, of the changes, and of the position (in Time) of this formation, which has yielded the world $1,000,000,000 in twenty-three years; and we have discovered that the source of all the gold is in certain subterranean *ore channels*, as well defined in many respects as are those of the ancient rivers.

Luck in quartz mining. It may appear some day, when we know a little more about it, that the man who expects to pursue profitably

the business of vein mining, without regarding or understanding the nature of these channels, ought to have expected some day to outlive his luck.

(2)– DISTRIBUTION OF GOLD.

Of the fifty or sixty elementary substances to which chemistry reduces matter, we find gold to be one of the heaviest, scarcest, and most independent of alliance, or tendency to mineral intermarriage; yet, like silver, the next following as a precious metal, and as truly as iron, clay, and quartz, it is universally distributed. **Characteristics and occurence.**

Silver is found in solution in sea-water, the world's envelope. Gold, though scarcer, we now begin to realize, is found in all countries. It has been found crystallized in veins or precipitations, belonging to all geological ages, including, even, the post tertiary in California. **All ages.**

It could not be otherwise. Gold and silver are both soluble, along with quartz, in the natural waters of the earth. They are extracted from their ores in California and Nevada largely "in the wet way." (See Age and Origin, Section 9, below.) **Solubility.**

In the following table are presented, as far as known, the instrumentalities that undoubtedly effect the transformation of gold, etc., underground, from a solid to a fluid state, and *vice versa;* being a list of the re-agents producing:

(3.)—SOLUTION AND PRECIPITATION OF GOLD, IRON AND QUARTZ, IN NATURE.

[Words in Roman refer to laboratory processes: those in italic to processes occurring in nature.]

1.—HOW GOLD, IRON AND SILICA ARE MADE SOLUBLE, AND DISSOLVED IN WATER.

RE-AGENTS WHICH, COMING IN CONTACT, PRODUCE CHEMICAL ACTION.		RESULT.
As Solids.	Solvent.	As Fluids, or in solution as
1. Iron, metallic.	Sulphuric acid and water.	Sulphate of iron.
2. " oxide.	*Same, from decomposition of pyrites.*	" "
3. " sulphuret.	*Alkaline, carbonate and sulphate waters.**	" "
4. " Sulphate.	*Water.*	" "
1. Gold, metallic.	Nitrohydrochloric acid (evolving chlorine), with water.	Chloride (sesqui) of gold.
2. " "	Chlorine gas (from salt and sulphuric acid).	Chloride(terchloride) of gold.
" "	*In nature, same, arising from the decomposition of pyrites and the never-wanting chloride of sodium.*	" "
3. " "	*Sulphate or sulphide of iron, in some way.*†	Disulphuret or sesquisulphuret(?) surrendering sulphur to iron on depositing.
4. " "	*Persulphate of iron.*††	" "
5. " chloride (sesqui).	*Water.*	Chloride(sesqui)
1. Silica.	*Alkaline (or basic) waters.*	Alkaline (or basic) waters.

2.—HOW GOLD, IRON AND SILICA ARE PRECIPITATED WHEN THEY HAVE BEEN DISSOLVED.

THE RE-AGENTS WHICH COMING IN CONTACT PRODUCE CHEMICAL ACTION.		RESULT.
As Fluids (in solution).	Precipitant.	As Solids.
1. IRON *sulphate, in water.*	*Organic matter.**	*Pyrites.*
2. *Iron sulphate and silicate solutions.*	*Organic matter.**	*Anhydrous oxide of iron.‡*
1. GOLD *chloride,* (sesqui).	*Proto-salts* (sulphates) *of iron, and heat.*	*Metallic gold.*
2. *Gold chloride (ter-chloride).*	*Sulphate of Iron.*	*Metallic gold, a black or brown powder, being the chlorination process.*
3. *Gold chloride (sesqui).*	*Hydrosulphuric acid, with heat.*	*Disulphuret of gold: a black powder.*
4. *Same.*	*Hydrosulphuric acid, without heat.*	*Sesquisulphuret of gold: a dark brown powder.*
5. *Same.*	*Same.*	*A black, pulverulent chloride(?) which when heated evolves fumes of hydrosulphuric acid, leaving metallic gold.*
6. *Same.*	Hydrosulphate of ammonia.	Same.
7. *Same.*	Protochloride of tin.	"Purple powder of Cassius" (oxide?)
8. *Same (terchloride) boiling hot.*	*Sulphydric acid.*	*Brown sulphuret of gold, AuS.*
9. *Same, cold and dilute.*	*Same.*	*Black persulphuret, AuS3.*
10. Disulphide(?) associ'd with sulphate of iron.†	*Organic matter.**	Metallic.
1. SILICA, dissolved in alkaline or basic waters.	Acid waters carrying sulphates of iron, etc.	Silica.

* Sterry Hunt.

† Hypothesis of John Arthur Phillips.

†† Similar idea to that of Phillips, definitely confirmed by laboratory process of Wurz.

‡ As at Steamboat Springs, according to J. A. Phillips.

(4).—PROCESSES OF CHEMICAL CONCENTRATION.

Going back to the dark ages of geology (with Murchison and Sterry Hunt), and remembering the high specific gravities and first affinities of these metals, we can conceive all the gold there was within some vertical Original condition

miles of the surface, as pretty evenly disseminated through the semi-molten azoic mud.

Active agencies of concentration.

Along with the fluvial replacements of material attending the everlasting rising and sinking of lands, chemical affinity or solution has kept this gold and silver moving ever since, wherever water moves—precisely like all the rest of the 50 or 60 elements of matter, and conforming as faithfully now as ever to the laws of physics and chemistry that govern all matter.

Authorities.

This is a resumé of the best judgment on the subject, of some of the most noted mining geologists in this and older mining countries, where the geology of silver and gold has been studied for hundreds of years.

Agency of the primitive ocean.

Prof. Sterry Hunt, of Montreal, has published an outline of the processes by which the silicious, calcareous, and argillaceous rocks, that form so large a part of the earth's crust, may have been generated from a primitive fused mass; and therewith has indicated the origin of the *salts of the ocean.* The first precipitates from the ocean would, according to Hunt, have contained most of the metals. In the subsequent re-solution and deposition of these precipitates is to be found an explanation of the origin of metalliferous deposits, and of their distribution in various formations, either as integral parts of the strata, or as deposits in veins, the former channels of mineral springs.

Precipitation and resolution.

"The metals of the Quebec group," he conceives, were originally brought to the surface in watery solution, from which they were "separated by the reducing agency of *organic matter* in the form of *sulphurets*, or in the native state, and mingled with the contemporaneous sediments. During the subsequent metamorphism of the strata, these metallic materials were taken

into solution by alkaline carbonates or sulphurets, and re-deposited in fissures."

(5).—MECHANICAL CONCOMITANTS OF THE PROCESS OF CONCENTRATION.

Ancient slates

To what depth the original mechanical concentrations with water in the soft crust of the globe extended, is a matter of slight practical importance. By the same laws of physics that now exist, concentrations took place in the paleozoic slates that were washed into basins and undoubtedly in many places sorted into layers.

Common chemistry

While this action took place at the surface, precisely as now, *under the surface* chemical affinity and chemical action must have set in and operated from the earliest dawn of creation precisely as now. And the results of chemical affinity being quite the same, whether in the wet way, or under pressure, or by fire, the methods of the chemical concentration of gold were also in general the same.

Work of the jurassic sea

In the usual and very natural method of drying, wrinkling, and surface oscillation that has caused the principal mountains and valleys of the globe, these slate muds might have been sinking for a long while, and *piling up* thicker and thicker, at the same time that the axis of the Sierra Nevada was rising. This much we can infer from the fact that the valley of Alta California has itself undergone such a process, being a valley of depression.

The coal mines of Mount Diablo and Corral Hollow will easily convince any observer of the latter. The coal veins deposited on the top of the cretaceous hills are seen to pitch under San Joaquin valley, where they have been explored, and also worked.

First stage. The Jurarsic and Triassic muds were no sooner deposited than they were disturbed. The Sierra Nevada began to rise before the cretaceous rocks on their flanks (near Shasta, Folsom, etc.), were deposited, since we see the latter lying nearly horizontal, on the upturned edges of the slates.

Parallelism. Veins are infiltrated cracks. What stronger evidence is needed, then, of the age of the gold-bearing veins of the Sierra, than that of their general parallelism to the axis of uplift and depression?

Inevitable. As soon as these breaks or cracks commenced forming, quartz, iron, and other minerals commenced precipitating in them. As soon as the proper mechanical and chemical conditions were supplied, from that time forward, and so long as the same laws of chemistry and physics remained in force, the same process must have continued and must ever continue.

The present day not being exceptional in that respect, there is no reason why vein concentrations should not be going on now.

Pinching out, gouge and faulting, in true fissure. The reason why we find *lenticular* "ore bodies" or chimneys that pinch out in most of the great fissure veins of the Tabular Exhibit, is made plain by Fig. 31. The dotted line E represents the original fissure. A dislocation of the country rock takes place, whereby the angle at the upper B in the foot wall slides down, and is now at B in the hanging wall. Of course, the hanging wall and the foot wall—originally identical—after this, cease to be parallel. The resulting lense or chimney shaped spaces were the recipients of mineral-bearing waters. Gouge was added to quartz, by continued rubbing, or dislocation of the walls.

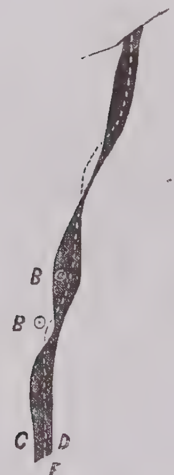


Fig. 31.—DISLOCATIONS CAUSING LENSE AND CHIMNEY-SHAPED SPACES.

(6).—THE MINERALIZERS OF GOLD: SILICA, IRON, ALKALIES AND SULPHUR, IN ARGILLACEOUS SEDIMENTS.

As the gold in quartz veins is undoubtedly attributable to chemical concentration in the wet way, we may reasonably also regard the argillaceous slate formation as *the matrix* of the gold-bearing veins. For if the gold solutions were derived from the underlying granite, or from matter more modernly erupted through the granite, we should find as many gold-bearing veins in the granite independently of the slates as in the slates themselves. Gold-bearing veins are found, it is true, in granite, on Placerville Divide at Logtown, as shown in the vein plottings; and at Meadow Lake, on the head waters of the South Yuba. But the fact remains that the great paying veins of California, Australia, and the Ural, are in slate. In slates, rather than granites.

As already remarked, gold is pretty universally distributed the world over, *but not* in a concentrated state. Mechanical accompanying chemical conditions.

It is most concentrated where the chemical conditions, accompanied by certain mechanical conditions, were most favorable for concentration and precipitation. Precisely as in the ancient river placers it was most concentrated where the mechanical conditions were most favorable for such concentration or separation from the accompanying rock.

Mineral ingredients of slates

We have here what was originally light mud, impregnated throughout with iron, gold, silver, besides the alumina, magnesia, silica, and lime, which formed the principal ingredients. Even where vein formation did not occur after the consolidation of the sediment, iron pyrites have very generally crystallized out in the slates. Such is also the fact in a more limited degree in the granites on the western slope of the Sierra. Quartz, iron, gold and magnesia especially, being easily soluble under the conditions to which they were subjected, formed the concentrations seen in the vein material and gouges associated with the metamorphosed seam belts; (several hundred specimens of which accompany this Report, and will speak for themselves.*)

Gold uncombined with iron sulphurets

The gold is found *precipitated as metallic gold,* free from combination with any of the above elements. Even when entirely inclosed in pyrites, it is granular upon disintegration of the latter. It is some times visible in undecomposed pyrites, with and without the assistance of a magnifying glass. [See instances in the tabular exhibit, Tuolumne County.]

Fourcroy's General System of Chemical Knowledge, published in 1804, has the following passage: "Berg-

* They have been donated to the State by direction of the President of the California Water Company, and are on exhibition in the mining and geological collection connected with the State Library at Sacramento

mann observes that the gold which is extracted from auriferous pyrites by digestion in nitric acid, is in small *angular grains*, which proves that this metal existed in the state of simple mixture, and not of composition in the pyrites."

Leading mineralogists of the present day all entertain similar views. In arriving at Nature's method of precipitating the gold, we may set it down as conclusive then, that the gold precipitates first. But the precipitation of iron, sulphuret is almost simultaneous. It appears to be the conclusion of the identical chemical reaction that precipitates the gold. Manner of precipitation.

(7.)—PHILOSOPHY OF ACTION, AND "AGGREGATE RESULTS."

Voltaic electricity is the soul of the earth, and like all other things in naturo, *dual*, or positive and negative in its manifestations. The electro-positive and electro-negative principle is not only the foundation of all chemical action, but it suggests to us the *modus operandi* of the vein chemistry of the Sierra, a matter of the greatest importance to those engaged in following the deposits of gold under ground. Electrometallurgy.

The Earth, in the order and plan of Nature, presents itself to us in three grand aggregates, (the "elements" of Aristotle,) *Land, Sea* and *Air*, to which should be added, perhaps, a fourth, the *Organic world*. Each of these four great natural aggregates of the chemical elements, is found to possess a feature chemically strikingly peculiar to it, viz.: land has *silica* as constituting fifty per cent. of all the rocks, or sixty per cent., if the limestones be excepted; water has *hydrogen*, the air has *oxygen*, and the organic world has *carbon*.* According Grand aggregates.

* Easily memorized by the initial letters in their natural order: S H O C

AFFINITIES AND FUNCTION OF THE LEADING ELEMENTS IN CHEMICAL GEOLOGY—THE DUAL PRINCIPLE OF ELECTRO-MAGNETISM AS OPERATING IN THE MOTHER LODE.

THE TWO CLASSES OF ELEMENTS ACTING UPON EACH OTHER.	TEST TO RECOGNIZE.	FUNCTION IN CHEMICAL GEOLOGY.	IF DECOMPOSED BY VOLTAIC ELECTRICITY, THEY—		CORRESPONDING— IN AGGREGATES OF NATURE TO—		CORRESPONDING— IN BROADER TERMS.	
Basic, or alkaline class of elements and compounds in solution: Alumina, Potash, Soda, Lime, Magnesia, Iron, and the metals generally.	Change red litmus paper to blue.	Dissolve or change silica, etc.	Go to the negative pole.	Called electro-positive.	The sea....	Fluid	The active principle.	Or masculine in the organic world.
Acid class of elements or compounds in solution:	Redden blue litmus paper.	Solidify or perpetuate in the form of silica chiefly, being the agency through which new mineral forms are constantly crystallized out, whenever the electro-positive or basic elements are brought in contact.	Go to the positive pole.	Called electro-negative.	The land...	Solid.....	The passive principle.	Feminine in the organic world.

to their leading ingredients, the earth and air would have to be considered electro-negative, or as most allied to the acid class, (in the table opposite;) the sea, and the organic world, as electro-positive, or as most allied to the basic class. Also paired.

(8.)—THE RESULTS OF CHEMICAL ACTION, AS WITNESSED IN CONNECTION WITH THE MOTHER LODE SYSTEM OF VEINS.

Those are "aggregate results" which we encounter in the seam diggings, alongside of the solid quartz veins of the mother lode system. Seam porphyry belts.

The one set of veins, the earlier, is acid; the other basic in its principal constituents. Both contain gold; the former is found in sulphurets, the latter more frequently in the form of free gold, associated with metallic oxides, carbonates and hydrous magnesium minerals, silicates of the bases mentioned in the table. Acid and basic gangue

What is the history, then, of the two different solutions and precipitations of gold? Simply that the acid and basic conditions alternated; that while the former endured, both iron and gold were in the fluid condition; and when the latter intervened, they were precipitated. They so remained, notwithstanding the fact that the accompanying quartz and sulphurets of the companion talcose veins and related seam diggings were subsequently decomposed, partially dissolved out, removed, and replaced by the hydrous magnesia minerals, the silicates of the bases which accomplished the metamorphism. This order of events did not in any manner interfere with the subsequent infiltration of silicious waters, and the formation of other or barren seams that are often found in the same neighborhood as the decomposed quartz seams, and kidneys in which the gold is found in sheets and pockets. Impregnation of seam belts

Basic or alkaline waters, in brief, *changed*, and carried quartz.

Acid waters carried gold, dissolved in sulphate of iron, or in the form of chlorides.

Where the two met, and the acid solutions were strongest, they *solidified* both the quartz and the gold, with iron, in the form of sulphurets.

Where, on the other hand, the basic solutions were strongest, there resulted *decomposition generally;* solution of quartz and transformation of everything into hydrous silicates of magnesia, accompanied by transformation of the sulphurets of iron and copper into carbonates and soluble sulphates, which were removed by water, leaving only the gold and oxides of iron.

(9.)—MINERALOGICAL CONTENTS OF VEINS, AND PARAGENESES.

The plan.

The mineralogical contents of veins are attributable to particular chemical combinations, which can be traced. In mining this is called *paragenesis.** It corresponds to the intermarriages of *individuals;* while the vein systems are *tribes*, where king and queen rule alternately; and the grand aggregates of Nature are the four nations in which Silica, Hydrogen, Oxygen and Carbon are the *absolute monarchs,* as already explained.

Significant items.

The main veins on Georgetown Divide are of quartz, or decomposed quartz, clay, gangue, etc., as described. The cross veins and seams frequently also contain solid quartz.

In many cases, the solutions in circulation could form quartz, etc., only to one side of the ore channel; on account of the country rock having been previously

* Very interesting treatises on the subject have been written by Breithaupt and others.

impregnated, perhaps, with different precipitating ingredients.

Further details, showing the peculiar contents of vein and seams on Georgetown Divide, and in their related vein systems, are given in the Tabular Exhibit, under Mining Sub. III.

(10.)—AGE OF GOLD-BEARING FORMATIONS, PREDICATED UPON THE ORIGIN OF GOLD.

We find gold and silver in the eastern slope of the Sierra Nevada in comparatively modern volcanic rocks. Ancient and modern.

We find gold not only in the "dark age," Silurian slates of the Ural, and of Australia, as demonstrated by Murchison, but in the "middle age," Jurassic and triassic slates of California; and even in the placer pyrites of the Pliocene rivers of the Pacific slope.

The latter occurrence has been repeatedly reported in the pyrites that crystallize in carbonized wood found in placer mining. We are assured that after a sufficient degree of care has been taken to exclude all possible mechanical admixture, some of the placer pyrites in Nevada and Sierra counties separated by specific gravity in water, are still rich in gold. J. Arthur Phillips endorses this view, upon the strength of facts observed by him while in California.

It is hardly necessary to enter into the question so tenaciously argued by Murchison, and some others since 1849, of the predominating, ancient or modern, age of the principal gold-bearing rocks. Geologists will try very hard sometimes to deduce a law, where they have found a repetition of what the prospector calls "the indications." Such "indications" had been observed by Murchison, which seemed to place the gold-bearing rocks of all the gold-producing countries known uni- Deduction

formly in the form of slates, into the dark ages of geological history.

Murchison and the slates

In the new edition of his "Siluria," Murchison modified, however, the views first put forth by him as to the distribution of gold in the earth's crust. His more recent conclusions are:

1. That looking to the world at large, the auriferous vein stones in the lower silurian rocks contain the greatest quantity of gold;

2. That, where certain igneous eruptions penetrated the secondary deposits, the latter having been rendered auriferous for a limited distance only beyond the junction of the two rocks;

3. That the general axiom before insisted upon remains; that all secondary and tertiary deposits (except auriferous detritus in the latter), not so especially affected, never contain gold;

4. That no unaltered, purely aqueous sediment, ever contains gold; or, in other words, that the granites and diorites have been the chief gold producers, and that auriferous quartz leads in palæozoic rocks are the result of heat and chemical agency.

But as checkers will range in lines in *four different* ways, so may the truth. Primary and secondary "indications," or results, of the truth, must be distinguished. The latter are reflected lights, echoes, or caroms of the first.

The law of gold distribution and concentration is as broad as that of the distribution and concentration of any other mineral.

Applied to Sierra Nevada

Murchison's reasoning concerning the origin of the gold deposits of California, would be, that the greenstone dykes, with their associated metamorphism, constitute the immediate cause of the impregnation of gold.

I have shown that these "dykes" are attending phenomena. If metamorphosed in origin (as I believe from my own observation), the causes of metamorphism were probably no less deep seated than if they had been erupted.

The result, then, so far as the concentration of gold in association with greenstone dykes is concerned, would be *quite the same;* even to the conclusion in which all agree, that we must regard the granites as the original source of the gold (as of every thing else); though not in any concentrated form. Common ground

Sedimentary concentration, such as Murchison claims peculiarly for the silurian, doubtless took place. But it continued with equal effect, as is conclusively shown by the facts presented in this chapter, down into the Jurassic. It is in the auriferous slate region that the great gold veins of California occur, while the granites are, as a rule, comparatively barren. To sedimentary concentrations, deposited in the carboniferous Trassic and Jurassic slates of the western parallels of the Cordilleran axis, we must ascribe the immediate source of the enrichment of the gold veins of California. In secondary rocks

(9.)—AGE OF THE GREAT CENTRAL VEIN SYSTEM OF SLATES.

Prof. Blake remarks "that the movements which attended the uplift and plication of the Coast mountains in the Post Tertiary must have affected the whole western slope of the Sierra Nevada." He therefore deems it probable that the principal impregnations of gold in the fissures of the auriferous slates must have taken place synchronously with the uplift of the Coast range, viz: after the end of the Tertiary. Post tertiary events.

The point is not well taken, except to the extent that

it may be possible to show what fissures were formed then that could not have been formed before.

Older than Miocene

The great central vein system of the auriferous slates certainly belonged to the period following the uplift of the Sierra Nevada immediately on their first consolidation to a mechanical condition consistent with nature's conception of the grand dome. Sufficient evidence that gold had been chemically concentrated in veins in this region before the Miocene Tertiary, is found in the fact of its having been mechanically concentrated to a large extent in the ancient rivers. in the form of a re-deposit of the metal; the age of which has been demonstrated by paleontological evidence, derived principally from the leaves and trees of the period, to have been miocene and pliocene tertiary at the latest.

SUPERFICIAL DEPOSITS.

1—Ancient and Modern Valleys
2—Volcanic Matter
3—Comparison of Ancient and Modern Drainage.
4—Constituents of Superficial Deposits.

(1)—ANCIENT AND MODERN VALLEYS.

General view.

Topographically and geologically there is a marked difference between the Georgetown and Placerville divides. Standing upon the summit of Grey Eagle Hill, or of Robb's Mountain, a view west and southwest shows the former to be irregular in outline—the latter a sloping plain, with only an occasional knob of metamorphic slate rising above the general level.

Geologically the former is uncovered slates, the "bed rock" formation of the Sierra Nevada—the latter a continuous gravel and lava deposit, covering a hundred square miles or more—beginning at the summit, and at its western end blending with the flat plain of the un-

denuded slates of Placerville Divide, above Mount Thompson.

While Georgetown Divide was a *divide* of the pliocene period, Placerville Divide was a *valley* of the same period. In it were heaped up the gravels of the pliocene river *filling* period, and upon the top of this poured the volcanic outflows of the eruptive period, which closed the pliocene, and marked the revolution which brought about the new order of things: the present topographical framework of existing watershed, valley and stream. The country in the ancient river period

From the summits of Georgetown Divide, looking toward the south, the Placerville gravel ranges fall prominently into view, and the gravel-pits, exposing the bed-rock of the ancient channel in a straight line which jumps from hill to hill, and from range to range, as if a ruled line had been drawn there in profile—present the most striking and interesting objects of landscape imaginable. Senic geology.

(2).—MOLTEN VOLCANIC MATTER.

On visiting Placerville itself, and ascending the high gravel range referred to, which trends westward just south of the town, you find all of the characteristics of the ancient river of the Yuba basin—an immense deposit of quartz, gravel and rock, covered by a mass of volcanic rock. Repetition.

So heavy and almost solidly continuous is the trachytic breccia in the vicinity of the reservoir—so entirely free of broken and rounded corners belonging to a transported breccia—that this difference at once occurs, however: that the lava of Placerville must have reached its position in a molten state; part of it entirely unmixed with river water. This character of the lava- Intestified eruption

flows of the Sierra is repeated and intensified toward the south in Calaveras and Stanislaus counties, while toward the north on the Yuba, the volcanic matter is generally (not always) in the form of volcanic washed boulders, in an ashy cement.

From the summit.

The volcanic matter of the Divide was derived from the summit. In localities in the vicinity of Tell's mountain the remnants of genuine molten trachytic lava-flows (or dykes?) exist, which were scraped over by the glaciers of the glacial period; it being almost certain that the rock is not in place.

(3) —COMPARISON OF ANCIENT AND MODERN DRAINAGE.

To the north of Georgetown Divide was another valley, now marked by the gravels of Forrest Hill and Iowa Hill Divide.

A comparison of the drainage of the Pliocene with that of the Post-Pliocene and recent periods, can be made from the following diagram, where the ancient stream is marked by a dotted line and the present one by a continuous line. The dark shading represents *canon;* the light, *plateau.*

The Middle Fork of the American, it will be seen, ran near its present route, but in the main a little further north; the South Fork was located further south than the present South Fork of the American.

The ancient side cañons are seen to exist in a manner corresponding with the cañons of Pilot Creek, Otter Creek, Cañon Creek, etc.

(4.)—CONSTITUENTS OF SUPERFICIAL DEPOSITS.

The material of the gravel deposits consists of:

1. *Gravel from the metamorphic slates,* chiefly diorites and silicous schists.

2. *Washed boulders of volcanic rock;* trachytic porphyry, or basalt, some of which is known as black lava. In lava capped hills of the mining region, the colors are generally owing to the various degrees of oxydation of the protoxyds and magnetic oxyds of iron contained in these lavas. In other cases the volcanic rock is from an ashy or leaden color to iron gray. The trachytic porphyry found in the form of volcanic boulders is often considerably lighter, and of a faint reddish tint.

3. *Ancient river sandstones* consisting:

(*a.*) Of sandstones of *granitic origin.* At Yankee Jim's, on the authority of Prof. Blake, several layers of placer deposit consist of fine granitic sand. On the authority also of Dr. Willey and Henry G. Hanks, there is in the deep placer mines, at Michigan Bluffs, a seam deposit formed of the component parts of granite. This is stained yellow and red with oxyd of iron. In portions of the placer beds, the sand is colored black by infilterated oxyd of manganese, looking at a little distance like black sand or lignite.

(*b.*) Sandstone of *volcanic origin,* known as white lava. The "white lava" is a fine gritty consolidation of volcanic sand and ash. It makes a tolerable building stone, being easily worked. It is used for this purpose at Diamond and Shingle Springs; is whiter and less compact than the porphyritic rock quarried at Green Valley, near Bridgeport, Solano County, which is said to harden on weathering. Some of the best

Fig. 32.—DIAGRAM OF THE PLIOCENE NORTH, MIDDLE AND SOUTH FORKS OF THE AMERICAN RIVER.

SHOWING THE RELATIONS TO AND VARIATIONS FROM THE PRESENT STREAMS.
SCALE, 6 MILES TO 1 INCH

R. D.—Red Dog.
Y. B.—You Bet.
L. Y.—Little York.
G. R.—Gold Run.
S. R.—Shady Run.
N. E. M.—N. England Mills.
C. G.—Copper Gap.
W. H.—Wisconsin Hill.
D.—Damascus.
I. H.—Independence Hill.
B.—Bath.
F. H.—Forest Hill.
Y. J.—Yankee Jim's
T. V.—Todd's Valley.
VOL.—Volcanoeville
B. H.—Bottle Hill.
S. D. D.—Spanish Dry Diggings.
GR.—Greenwood.
P.—Pilot Hill, (town of Centerville)
J.—Johnston.
K. Kelsey's.
G. E. H.—Grey Eagle Hill.
C.—Coloma.
G. H.—Gold Hill.
D. S.—Diamond Springs.
N.—Newtown.
R. R.—Railroad.

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buildings at Mokelumne Hill, Calaveras County, are likewise constructed of volcanic material.

4. *The soil of the country*, consisting of decomposed slates to a depth of five or ten feet. It is from cherry red to brown, yellow, or nearly white, depending upon the amount of iron in different localities.

V.—WATER, AND ITS APPLICATION.

(1.)—THE DEMAND

Mining. For water, of course, *regulates* the extent of all works and operations for supply. From the nature of the seasons the principal demand occurs in summer; although for mining purposes the desideratum of regularity, as well as quantity of supply, throws almost the entire water market of the divide the year round into the hands of the California Water Company.

Water sales. The extent of the present demand for mining and agriculture is not fully represented by the actual water sales as taken from the books of the Water Company, kept at Georgetown, the demand having exceeded the supply. Owing to continuous construction since the purchase of the property, no fair average of sales can be made from the Secretary's books.

Permanency. The demand for water, both in mining and agriculture, depends fundamentally upon the degree of activity or general prosperity in those interests peculiar to the Divide, concerning the fluctuations of which I have enlarged under VIII. These fluctuations, as shown, are owing to a large extent to conditions independent of the real resources of the country. The degree of permanence of demand is based then upon the permanent or substantial character of these resources, in

agriculture and mining. The question whether these resources of the divide are such as to warrant any expectation of increased demand, with the ability on the part of the consumers to pay, is the question to be particularly considered under the heads of "Mining" and "Agriculture," respectively regarded as permanent resources, in accordance with the facts presented in this report.

(2.)—THE SUPPLY.

(*a*) IN WINTER—The present limits of supply are, in winter, the full capacity of the several ditches, as given below under section four. Capacity of ditches

For winter supply, the *local* sources from various tributaries, from Dutch Creek, Rock Creek and Cañon Creek—in short, every principal stream of the divide—are ample to fill all the ditches owned by the company at once, and in general for six months in the year. (See "Rainfall" and "Physical Geography.")

(*b*) DURING THE SUMMER.—In summer, the limit of supply is the *minimum drainage* of the season, in connection with the *catchment* at the sources of supply: (*a*) Pilot Creek and Pilot Creek reservoir, (*b*) Little South Fork and Loon Lake reservoir; (*c*) Rubicon River and the Glacial Lakes, used as reservoirs. Regions of summer supply

Results of measurements are given below, showing the storage capacity at your disposal, in various lakes and reservoirs.

The Loon Lake reservoir waters, in addition to those of the Pilot Creek reservoir, would be drawn upon from June 15th to November 15th—five months, or 150 days. Water is at its lowest stage about September 20th; it runs quite low for about three months. Dry season

There is required for present wants, beyond the sup-

ply which was had during the past summer, at least one thousand inches for 150 days.

(3.)—LIMITS OF STORAGE SUPPLY.

Correct policy

The wisdom of continuing your system into Loon Lake, or Little South Fork basin, and Rubicon basin, is founded upon bed-rock principle. The provision of nature here discovered by explorers placing the California Water Company in possession of important geographical advantages for the supply of *summer water*, in quantities not merely to answer for the needs of Georgetown Divide, but the valley and the cities of the valley, is barely indicated under the Physical Geography of the Divide.

Rubicon basin, with its perpetual snows, is one grand *store-house* of the aqueous element, which changes into self-transportable fluid only in the dry season, when it is wanted.

Melting snows.

Running lengthwise—northwest and southeast—in the heart of the Sierras, for a distance of 15 or 20 miles, the Rubicon River basin holds several hundred square miles of snow, 10 to 30 feet deep; the melting of which begins in April or May in the bottom of the valleys, and recedes to higher and higher altitudes as the wants of the dry season require it. Until, in the latest and dryest months, there is still an unexhausted supply held over, into the succeeding year.

Glacial reservoirs.

The entire basin of the Rubicon, as well as that of the Little South Fork is *glaciated*, and dotted with innumerable lakes of glacial origin. Some of these are of great extent, and very deep. Enclosed within lateral and terminal moraines, consisting of a narrow rim of loose material easily dug, these lakes are natural dams or reservoirs capable of standing an enormous pressure,

and in most cases of being raised by a slight artificial reconstruction of the eroded outlet, to a reservoir capacity greatly increased above their present natural capacity.

Here are found, then, the elements of a water supply in quantity worthy of a water company of the broadest foundations and the most extensive operations in prospective. Situated opposite the most important portion of the valley, in a geographical point of view, and the capital of the State, this wealth in water may be applied successfully, and under good management immediately, to widely varied industries, all of which are assured, and must be as permanent as population and prosperity in the State. Business elements

Von Schmidt goes further, and proposes to tunnel the Sierra, besides digging fifty miles of ditch, in order to attain what you already possess—a completed ditch from the snowy store-house of the high Sierra to the valley, and a supply of water more abundant during the dry season than the largest ditches can convey. Lake Tahoe

The magnificent reservoir of Lake Tahoe cannot be taken advantage of by Von Schmidt's scheme to any greater extent than can the summer flow of the Rubicon River, in connection with the numerous reservoirs of the Little South Fork and Rubicon basin, by the California Water Company. Not superior

Of the methods of gaining the full advantage of the situation and wealth of Rubicon basin, in connection with your Little South Fork system, the proper policy to pursue is considered under Subdivision VIII. Policy

To meet present wants, and for present purposes in general, there is no immediate necessity for the construction of the connecting line to the Rubicon. The demand will undoubtedly appear, however, as soon as Present and future

water can be had; and to the fullest extent of the capacity of the main conducting channel; for which see Little South Fork Ditch and Pilot Creek Ditch.

THE RESERVOIR CAPACITY REQUISITE

Must correspond, in some degree, with the rates of rainfall and consumption.

How to calculate. The capacity of the reservoir is the difference between the natural level and the raised level. The amount of this difference should equal a capacity of impounding sufficient to provide a certain *fixed constant* supply; the same to be maintained during the longest period of drouth.

(1.)—PILOT CREEK AND PILOT CREEK RESERVOIR.

The actual present sources for summer supply are limited to Pilot Creek basin and Pilot Creek reservoir, The new ditch in process of construction, and nearly completed, is intended to throw into the latter the summer waters of the Little South Fork basin, including Gurley Creek and Loon Lake reservoirs.

The North Fork of the Middle Fork contains, according to records in the Water Company's office, at the junction nearly double the amount of water of the South Fork. The latter, on June 24th, 1871, was about fifty feet wide, six feet deep, and running at the rate of four to five miles an hour; approximately 43,200 miners' inches.

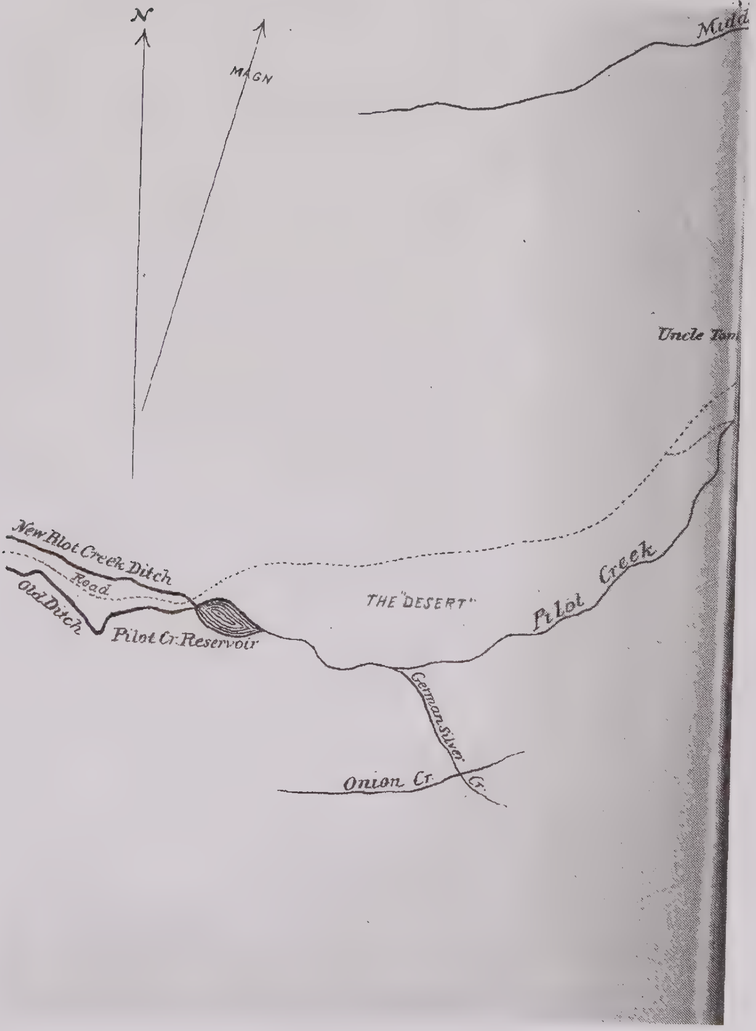
(2.)—THE LITTLE SOUTH FORK

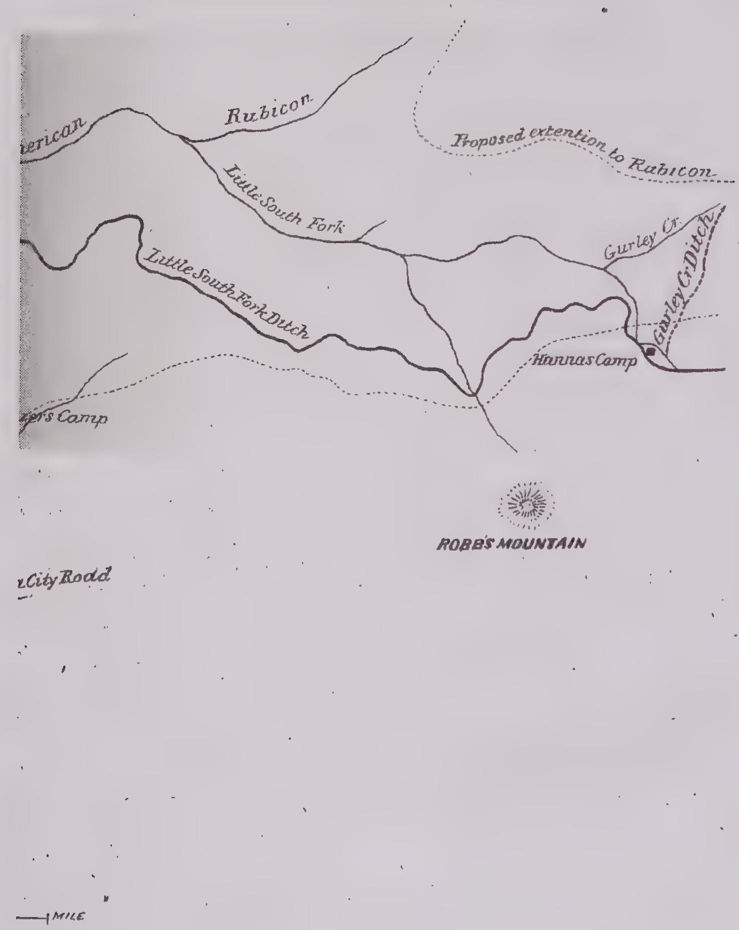
Itself, and Gurley Creek, were nearly dry when I saw them in August, 1873; and Loon Lake did not discharge any surplus water for two or three months. From evaporation (chiefly), Loon Lake receded sixteen inches.

[The Little South Fork, at the trail crossing, was, on

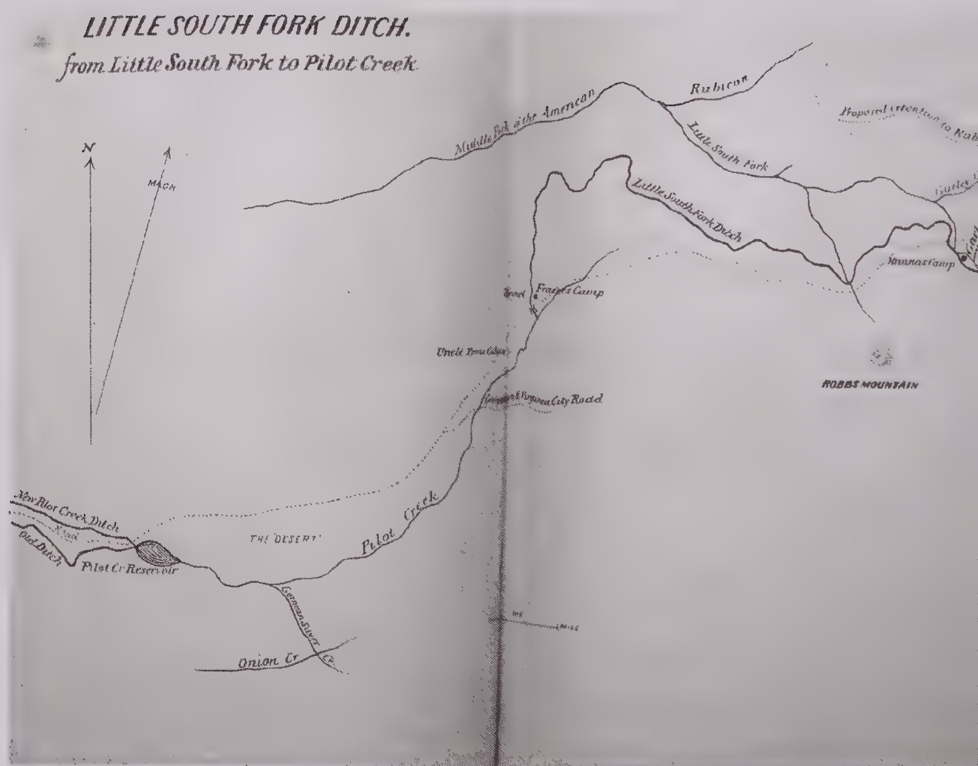
LITTLE SOUTH FORK DITCH.

from Little South Fork to Pilot Creek





erican
Rubicon
Proposed extention to Rubicon
Little South Fork
Little South Fork Ditch
Gurley Cr.
Gurley Cr. Ditch
Hannas Camp
ers Camp
ROBB'S MOUNTAIN
City Road
1 MILE



LITTLE SOUTH FORK DITCH.
from Little South Fork to Pilot Creek

June 24th, 1871, reported to be ten feet wide, two and a half feet deep, and running at the rate of three miles an hour.]

The Little South Fork at its outlet was estimated as flowing 4,000 miners' inches on June 25th, 1871.

Gurley Creek, the outlet of Loon Lake, empties into the Little South Fork about five miles above its junction with the Middle Fork.

Had the Little South Fork and Gurley Creek ditch been completed in August, the waters stored in Loon Lake—an estimated capacity of 10,000 inches constant flow—would have been drawn upon at this juncture, and the ditches might have been kept full for at least 100 days.

A temporary dam, nine feet high, was constructed at the outlet of Loon Lake, as represented on the map, to see if any of the water of Loon Lake, when dammed, would seep away. The lake remained full all summer. Loon Lake so dammed connects with Pleasant Lake, making both together about three miles in length, and half a mile in width.

Mr. Bradley proposes to draw off the water from the surface of the lake when filled twelve feet above the natural level, to a level twenty feet lower, by tapping the lake by means of a tunnel eight feet below the natural level. He estimates that he can supply in this way a flow of 5,000 inches during the summer and fall months.

The summer supplies which may be drawn from Little South Fork basin are taken from measurements made by direction of the Company, as follows:

The Little South Fork is the outlet for ten small lakes, embracing three and a half millions square feet of surface, which can be increased one third by inexpensive dams, averaging 10 feet high, across narrow

gorges. The flow from them would be from 3,000 to 21,000 miners' inches.

Loon Lake System alone will flow, according to calculation 10,000 inches during the dry season. It receives its waters from the precipitation embraced in a basin about eight miles in diameter. Loon Lake is one half by one quarter of a mile in dimensions, and 29½ feet average depth. A dam 20 feet high and 236 feet long would double the surface area. Six small lakes tributary to Loon Lake can also be doubled in surface area and capacity.

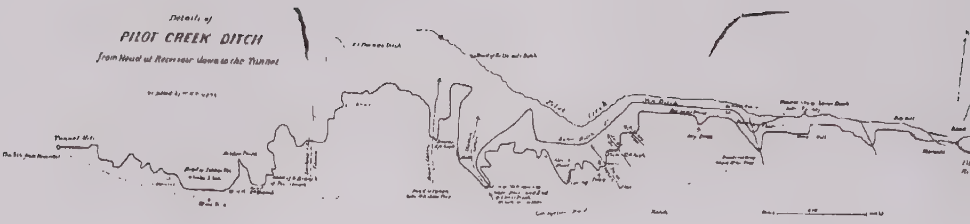
Loon Lake has a present surface of 104,688,000 square feet, which can be more than doubled by a dam 20 feet high and 236 feet long. To this lake belongs a system of natural reservoirs, six in number, each of which can be raised by dams so as to double the present capacity, viz: (as numbered on Reservoir Plots upon tracing cloth in the office of the Company.)

(1.) Measures one fourth by one eighth of a mile in dimensions; having 900,000 square feet of surface. To double this capacity a dam 20 feet high and 200 feet long can be constructed.

(2.) Horse Shoe Lake, one eighth by one tenth of a mile in dimensions; having 400,000 square feet of surface. A dam 10 feet high and 175 feet long will double the capacity.

(3.) A lake containing 800,000 square feet of surface. By means of a cut 5 feet deep and 200 feet long, and a dam 10 feet high and 250 feet long, the capacity may be doubled.

(4.) Pleasant Lake. The water of Pleasant Lake flows into the outlet of Loon Lake about 2,600 feet below its emergence from the lake. Pleasant Lake is 75 feet above Loon Lake. It contains one-quarter of a


Details of
PILOT CREEK DITCH
from Head of Reservoir down to the Tunnel

million square feet of surface. A dam 15 feet high and 300 feet long; also a cut two feet below its present surface and 300 feet long, are practicable. The flow in June 1871 was 250 miner's inches.

(5.) A lake having one quarter of a million square feet of surface. It can be tapped by a tunnel 200 feet long so as to drain the lake 25 feet below its present surface, and furnish 2,650,000 cubic feet of water, also dammed 20 feet higher by a dam not exceeding 150 feet in length. Half of its water runs from a marshy plain below its outlet to Pleasant Lake; the other half down Gurley Creek, joining it two or three miles below Loon Lake.

(6.) A lake having 200,000 square feet of surface. A dam 20 feet high and 200 feet long will double its capacity.

At the head of the Little South Fork system, is lake "F," as designated, containing about 45 acres, and having several adjacent reservoirs. Also lake "A," containing 30 acres, which can be dammed by a structure 10 feet high and 150 feet long, so as to cover 40 acres. It has four adjacent lakes, all capable of being dammed.

(3.)—RUBICON RIVER AND LAKES TRIBUTARY THERETO.

This source of supply was had in view in 1871, in ordering a survey for a line of ditch to throw the waters of the Rubicon into Gurley Creek, at a point connecting with the Little South Fork and Gurley Creek systems. The water supply from this source, by taking advantage of the storage of the natural reservoirs, is estimated as follows:

The RUBICON SYSTEM of streams and reservoir lakes furnishes in the dry season 12,000 miner's inches. The

principal lakes are C. D. and E., as designated,—Spider Lake, Lower Lake, and Potter's Lake,—each connecting with from one to ten smaller lakes.

Little Rubicon.—The Little Rubicon, measured in June, 1871, at a point two miles below these lakes, 2,336 miners' inches.

Potter's Lake and *Lower* Lake are on the Little Rubicon, about three miles south of its junction with the main Rubicon, and about seven miles below, its source in the snowy peaks of Tell's Mountain range.

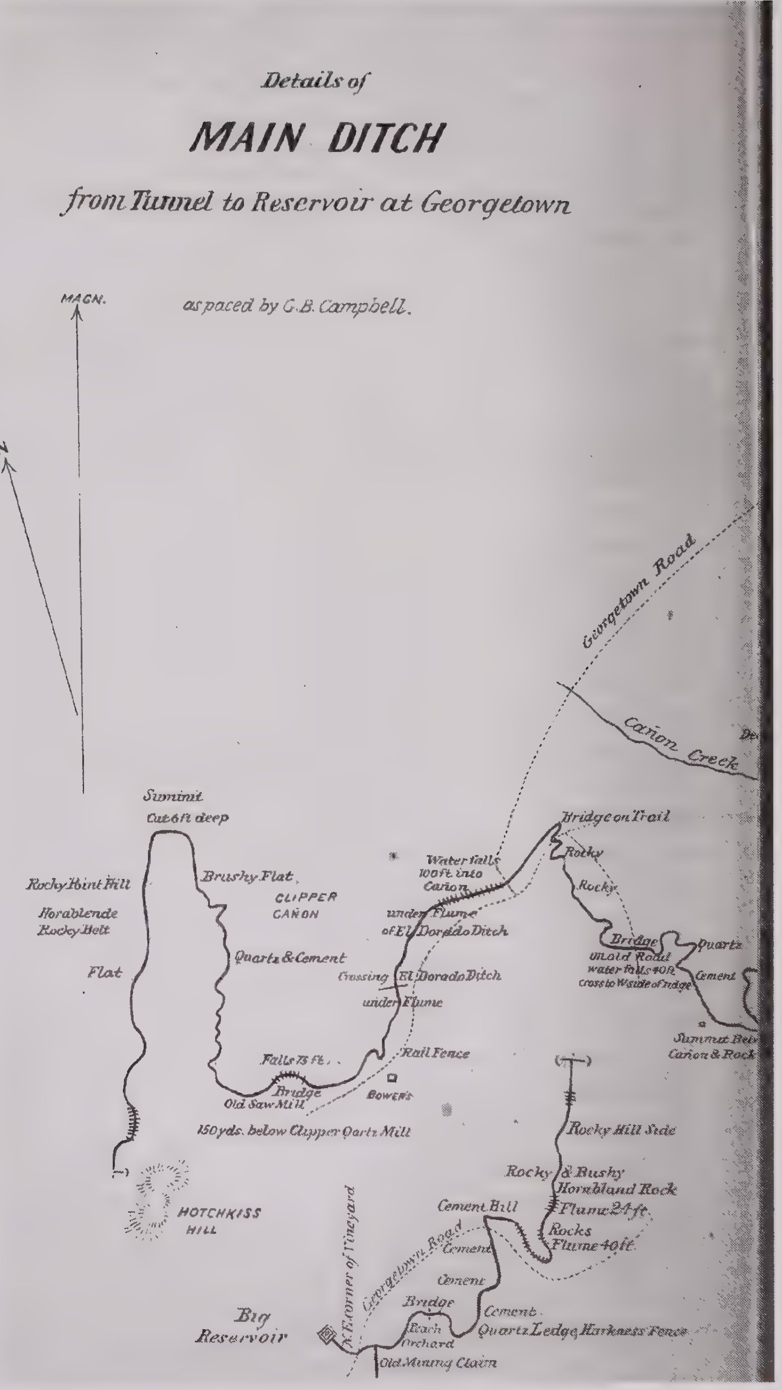
Spider Lake, (C.) contains 15,000,000 square feet of surface, and is very deep. A dam, 20 feet high, by 320 feet long, would double its capacity. It can also be lowered by tapping it 40 feet below its present surface, requiring a tunnel 800 feet long. The raising and tapping together would afford a draught of 60 feet, giving 1,000,000,000 cubic feet of water. The *auxiliary* reservoirs are:

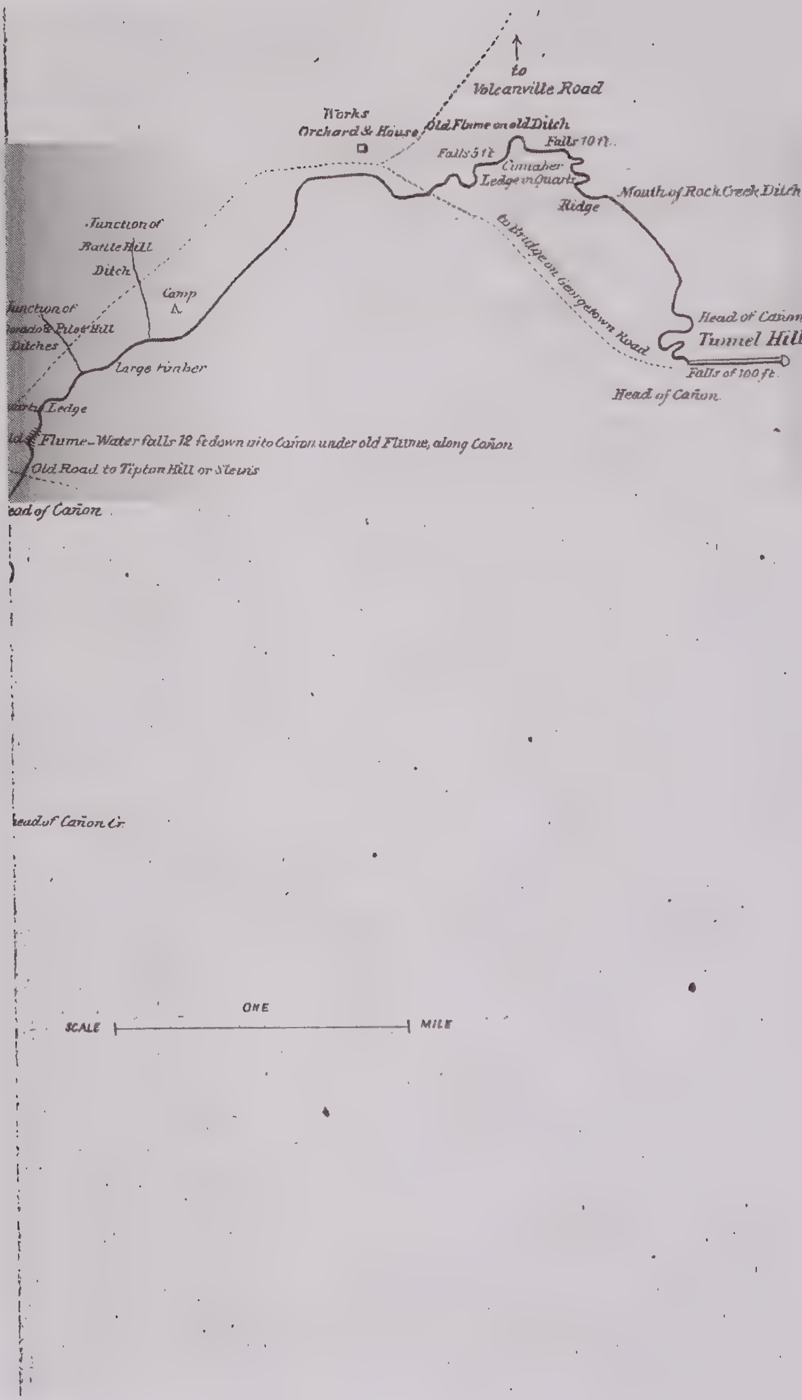
1. A small lake, one third of a mile long by 400 feet wide, containing 350,000 square feet of surface, susceptible of being increased one third by a dam across the outlet 61 feet high by 300 feet long.

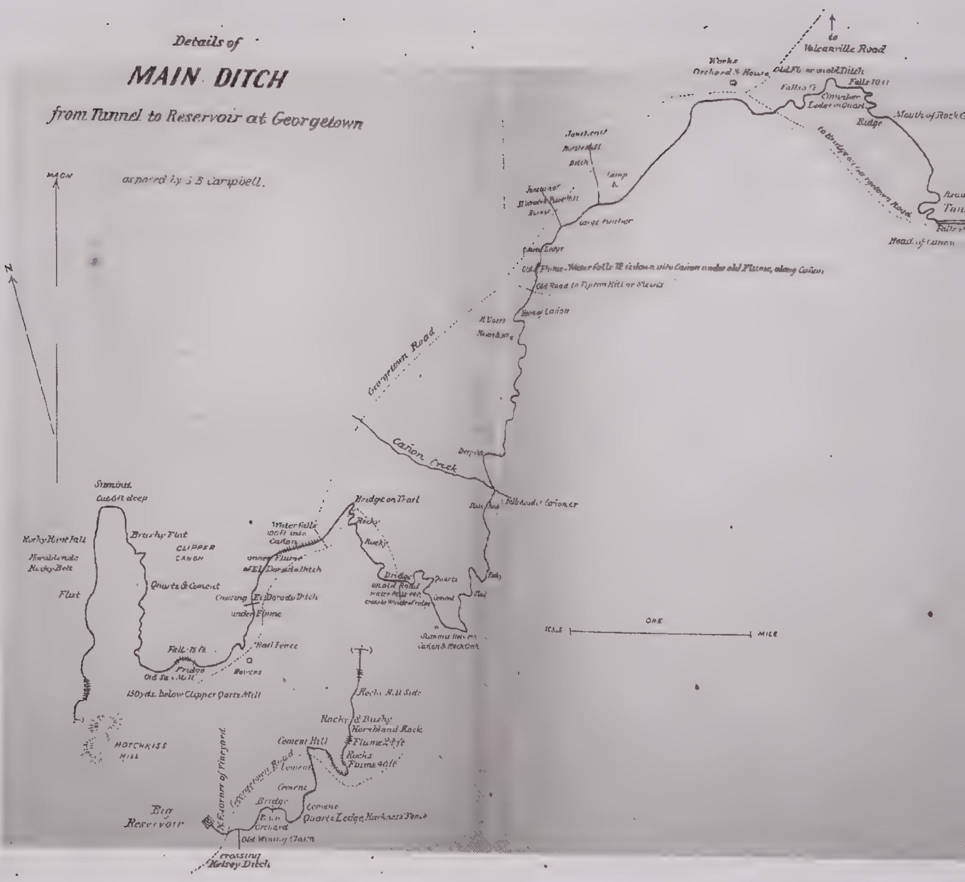
2. A small lake, half the size of the last named, situated one fourth of a mile southwest from it; besides several other small lakes.

Swan, or Lower Lake, (D.) has over 2,000,000 square feet of surface. The Little Rubicon flows through it, entering it at its southeastern extremity, and leaving it at its northwestern extremity. It has two separate outlets, which can be dammed by bulkheads, each 20 feet high by 275 feet long, and tapped by an open cut three feet deep and 60 feet long. The *auxiliary* reservoirs are:

1. A small rock-bound lake, lying due east of the outlet of Swan Lake, which can be directed into the latter


Details of
MAIN DITCH
from Tunnel to Reservoir at Georgetown
as paced by C.B. Campbell.
MAGN.
N
Georgetown Road
Cañon Creek
Summit
Cut 6 ft deep
Rocky Point Hill
Hornblende
Rocky Belt
Flat
Brushy Flat
CLIPPER
CAÑON
Quartz & Cement
Falls 75 ft.
Bridge
Old Saw Mill
150 yds. below Clipper Qartz Mill
Water falls
100 ft. into
Cañon
under Flume
of El Dorado Ditch
Crossing El Dorado Ditch
under Flume
Rail Fence
BOWERS
Bridge on Trail
Rocky
Rocky
Bridge
on old Road
water falls 40 ft.
cross to W side of ridge
Quartz
Cement
Rocky Hill Side
Rocky & Bushy
Hornbland Rock
Flume 24 ft.
Rocks
Flume 40 ft.
Cement Hill
Georgetown Road
Cement
Cement
Bridge
Cement
Quartz Ledge Harkness Fence
Peach
Orchard
Old Mining Claim
N.E. corner of Vineyard
HOTCHKISS
HILL
Big
Reservoir


to
Volcanville Road
Works
Orchard & House
Old Flume on old Ditch
Falls 10 ft.
Falls 5 ft.
Cinnaber
Ledge in Quartz
Mouth of Rock Creek Ditch
Ridge
to Bridge on Georgetown Road
Junction of
Rattle Hill
Ditch
Camp
Head of Cañon
Tunnel Hill
Falls of 100 ft.
Head of Cañon.
Large timber
Ledge
Flume–Water falls 12 ft down into Cañon under old Flume, along Cañon
Old Road to Tipton Hill or Stevens
SCALE
ONE
MILE


Details of
MAIN DITCH
from Tunnel to Reservoir at Georgetown
Volcanoville Road
Works Orchard & House
Mouth of Rock
Ridge
Head of Canon
Camp
Georgetown Road
Cañon Creek
Bridge on Trail
Summit
Rocky Point Fall
Brushy Flat
CLIPPER CANON
Quartz & Cement
Flat
Crossing El Dorado Ditch
under Flume
Fall 15 ft.
Rail Fence
Old Saw Mill
Bridge
130yds. below Clipper Quartz Mill
HOTCHKISS HILL
Rocky & Brushy
Hornblend Rock
Cement Hill
Georgetown Road
Cement
Bridge
Quartz Ledge
Harkness Fence
Big Reservoir
Orchard
Old Mining Claim
crossing Kelsey Ditch
SCALE
ONE
MILE

above its outlet by a small ditch. This reservoir can be doubled in capacity, by means of a dam 20 feet high and 150 feet long, which would give the reservoir 400,000 square feet surface.

2. A small lake, one mile south of Swan Lake, and 200 feet higher. It has a surface of 200,000 square feet.

Potter's, or Big Blue Lake.—This is one mile long by five eighths of a mile wide, and is situated one fourth of a mile above Swan Lake, and 120 feet higher. It has a surface of 11,000,000 square feet, and is very deep.

A large lake above, discharges its surface waters into it through the Little Rubicon. A dam of an average height of 11 feet by 436 feet long, would raise the lake 20 feet, and a cut or tunnel, 600 feet long, would tap it 30 feet below its present surface. Three or four connecting lakes, embracing about 500,000 square feet of surface, are tributary to Potter's Lake.

The Big Rubicon flowed, in June, 1871, from 4,000 to 5,000 inches. It runs nearly parallel with the Little Rubicon for about three miles. It was in August 20 feet in width, three feet in depth, and flowed at the rate of two miles per hour, giving 4,320 miners' inches.

The total area of the reservoirs and lakes above is 143,202,600 square feet, allowing the average depth to be ten feet.

The total number of cubic feet in all the lakes would be 1,432,126,000, or 10,000 miners' inches, for 440 days; or 20,000 miners' inches for 220 days.

4.—DITCHES.

ORIGIN, CHARACTER AND EXTENT OF THE DITCH SYSTEM.

Every portion of the Divide is covered by ditches of the **Absorption.**
California Water Company. Besides the main ditches for summer supply, the old S e ditch and the El Dorado

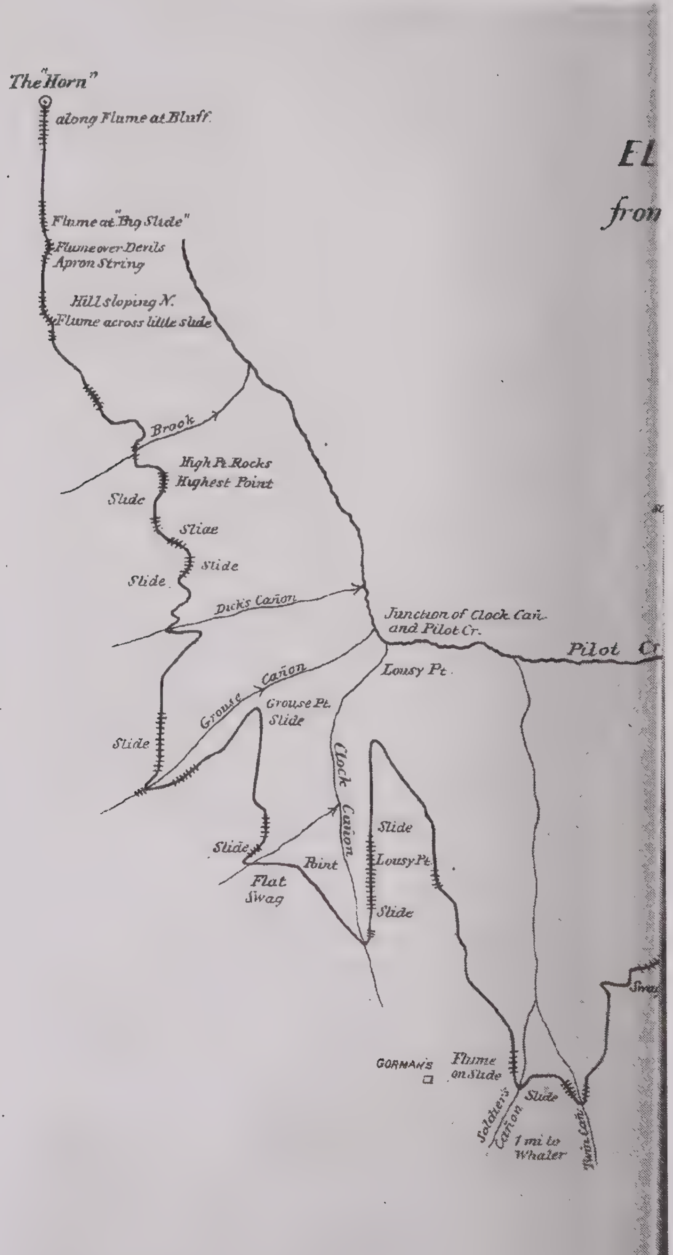
ditch leading up into the high Sierra, there is a large number of distributing ditches, connected with numerous subordinate ranch ditches, which were constructed to take advantage of local streams for mining purposes; yet which may all be considered, and are equally useful as agricultural ditches in the summer season. The original survey, construction, and even the absorption of all these ditches, was the work *of many persons*, the predecessors of the California Water Company.

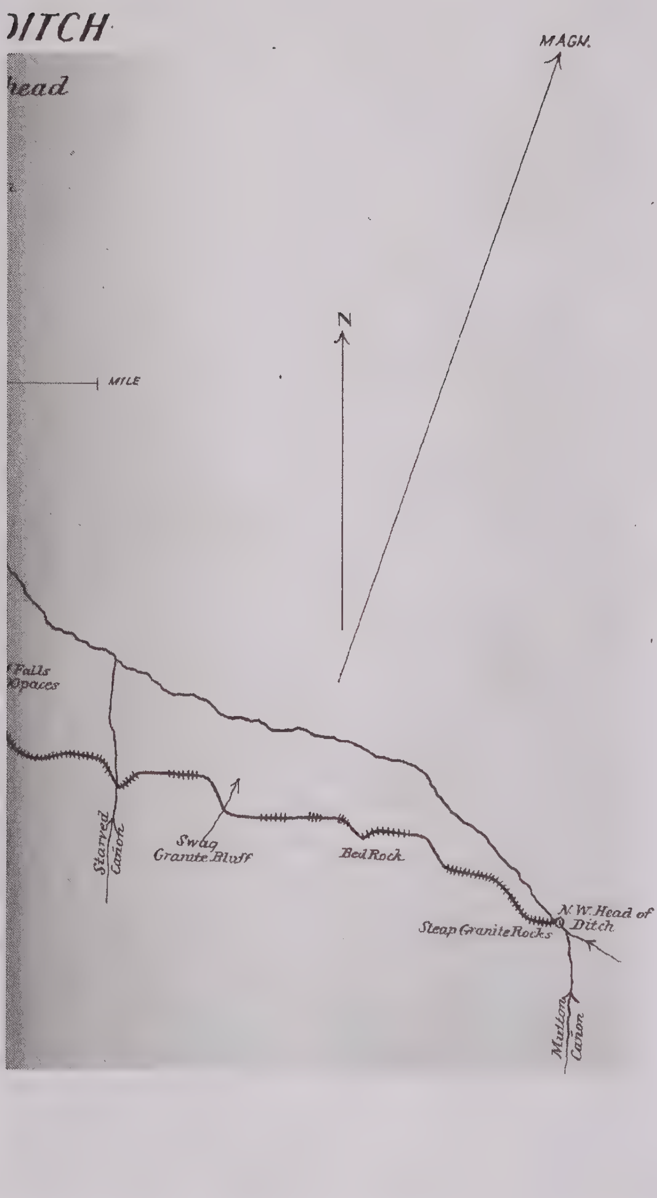
In gaining possession of so extensive a system of water rights, ditches and reservoirs, the sum of all that the surface mining of the early period was able to develop, in the way of permanent improvements on the Divide, the California Water Company *has reaped* all the advantages that could be derived from purchasing them during a period of decadence, having obtained these properties at a fraction of what they originally cost. Yet the circumstances, it is believed, warrant the conviction that through good management and a fair discrimination, the resources of the Divide will very speedily prove themselves worthy of the undertaking; and the values of these properties will shortly recover to their original standard; in the meantime maintaining the character, from a financial standpoint, of a very fair, permanent and promising field of investment.

Decadence and recovery.

Want of water.

Many of these ditches are but small, and no longer adapted primarily to the uses for which they were constructed—surface mining—and have not yet been turned to account for any other purpose. Many of them have been allowed to go to decay, being overgrown with chemisal, and broken through at most of the ravine crossings by winter brooks; the flumes being frequently rotted to the ground. But as distributing ditches for agricultural purposes in the dry season, they can be


The "Horn"
along Flume at Bluff.
Flume at "Big Slide"
Flume over Devils Apron String
Hill sloping N.
Flume across little slide
Brook
High Pt. Rocks
Highest Point
Slide
Slide
Slide
Slide
Dick's Cañon
Junction of Clock Cañ. and Pilot Cr.
Pilot Cr
Lousy Pt.
Grouse Cañon
Grouse Pt. Slide
Slide
Clock Cañon
Slide
Lousy Pt.
Slide
Slide
Point
Flat Swag
GORMAN'S
Flume on Slide
Slide
Soldier's Cañon
1 mi to Whaler
Twin Cañ.
EL
from



)ITCH
head
MAGN.
N
MILE
Falls
0paces
Starved Cañon
Swag Granite Bluff
Bed Rock
N. W. Head of Ditch
Steap Granite Rocks
Mutton Cañon


EL DORADO DITCH
The "Horn"
along Flume at Bluff
Flume at "Big Slide"
Hill sloping N.
Flume across little slide
Brook
High Pt. Rocks
Highest Point
Slide
Slide
Slide
Slide
Duk's Cañon
Junction of Clock Cañ. and Pilot Cr.
Pilot Creek
Lousy Pt.
Grouse Cañon
Grouse Pt. Slide
Slide
Clock Cañon
Slide
Lousy Pt.
Slide
Slide
Point
Flat
Swag
Flume on Slide
Slide
GORMANS
Soldier's Cañon
1 mi to Whaler
Swag
Swag
Granite Bluff
Bed Rock.
N.W. Head of Ditch
Steep Granite Rocks
Mutton Cañon
MAGN.
N
SCALE
MILE

brought into use, at a comparatively small expense, the moment that there is *water enough at your command* to warrant the development of a market in this direction.

ADVANTAGES OF COMBINING ALL THESE DITCHES UNDER ONE GENERAL SYSTEM.—You are not in the position upon getting an abundant summer supply from the high Sierra—after you have been expending large sums on construction—of having to wait many years for the completion of these ramifications for distribution, which are so necessary to turn the water when you have it, into cash. You have every portion of the *Divide at your command.* The resources of the country have been well canvassed; and there is only required of you the practical business talent, along with the necessary attention to details, to choose the most promising localities, and secure the application of water wherever anything exists, in either of the three kingdoms of nature, that can be made to blossom into prosperity. One executive field.

The system of ditches, as succeeding in their order the processes of catchment, storage, conduction and distribution, embraces: (1.) main ditches for conduction from the region of supply or storage to the region of application or market; (2.) tributary and distributing ditches. Classification of ditches.

In this light, your list of ditches, with connecting branches, presents itself to the eye as in the accompanying table; those not owned by the California Water Company being designated by a star.

In the ditch maps accompanying this description the cross lines indicate flumes.

(I.)—EAST OF GEORGETOWN.

(a)—PILOT CREEK SECTION.

THE MAIN DITCH.—The size of the old Pilot Creek Ditch, from its upper end, at the Pilot Creek Reservoir,

down to Mutton Cañon, is three and a half feet on top, two and a half feet at the bottom, and two feet deep. Water is constantly running in it. It is a well-constructed ditch, and in good condition. From its head to Ballard's Cañon, a distance of about six miles, it is covered with rails. It was covered formerly for some distance farther down, but the covering was taken off, and put on the new Pilot Creek Ditch. A portion of it was burned up by forest fires.

The size between the mouth of Mutton Cañon and Georgetown is six and a half feet on top, four feet at the bottom, and three feet deep. On August 15th, 1873, there were running in this, at the flume, four and a half feet by six inches of water. It has been dry only once since its construction; namely, in 1871. This portion is also well constructed, and in first-rate condition; is always carrying water. It was enlarged by this company. Before the enlargement, it was calculated to run 900 inches; it now runs from 1,800 to 2,000.

The New Pilot Creek Ditch takes the water out of Pilot Creek, two miles below the Pilot Creek Reservoir, and half a mile below Forney's. The size from its source to Mutton Cañon is three and a half feet on top, two and a half feet at the bottom, and two and a half feet deep. The object in constructing this ditch, taking the water out of Pilot Creek below the reservoir, was to get the leakage from the reservoir, and to carry a greater amount of water down the divide than the old Pilot Creek Ditch could carry, as far as Mutton Cañon. From that point, towards the west, the old Pilot Creek Ditch was enlarged, as stated, in order to carry the waters of both ditches.


Details of
EL DORADO DITCH
from Junction with Main Ditch up to the "Horn"
as pared by W. H. Vaughn
SCALE
ONE
MILE
N
MAGN.
American River So. Branch.
Peterman's Mine (in cement)
Marshalls
Cabin
Flume
Main Ditch
Bridge
Road
Swag
Works
Stockton's
Log Store
Fence
Otter Creek
Slate outcrop
So. Fork
Dry Ravine
Slide
Swag
Middle Fork
Slate outcrop
Crazy Mans Gulch
Volcanoville Road
Flume 37 Falls
Slide
Swag
N. Branch
Road
10 in. water joins Ditch
Flume 10 ft high
Otter Creek
Volcanville
Ditch
Mitchells
Swag
Gulch
Dry
Crazy Mans Cañon
Main Point of Tunnel Hill
Spring
Flume on Bed Rock
Slate outcrop
Sheep trail
Bluff Rock 20 ft high
Flume on Slate
The "Horn"

(b)—BRANCH DITCHES—PILOT CREEK SECTION.

1. BRANCH OF SILVER CREEK DITCH takes the water from Onion or Silver Creek to Pilot Creek, emptying into Pilot Creek Reservoir. Size, two feet on top, sixteen inches at the bottom, and sixteen inches deep. Water is constantly running in it. On August 15th, 1873, there were ten inches.

2. EL DORADO DITCH.—This ditch takes the water out of Pilot Creek, several miles below Forney's, and follows the left bank of Pilot Creek to its junction with the Middle Fork; thence attains Mount Gregory Divide, and feeding the Volcanoville Ditch, continues toward Works' Ranch; following from that point within a few yards of the main Pilot Creek Ditch, the only accessible route along the divide to Georgetown. Below its junction, with the main ditch, the size of the El Dorado Ditch is three and a half feet on top, two feet at the bottom, and three feet deep. On August 15th, 1873, there was water running in it five or six inches deep. Above its junction, with the main ditch, the size is thirty inches on top, eighteen inches at the bottom, and twenty inches deep. It runs 350 inches or more, the year round. Below Hotchkiss Hill, the El Dorado Ditch has been enlarged to six feet on top, three and a half feet at the bottom, and three feet deep to Georgetown.

3. THE VOLCANOVILLE DITCH is a branch of the El Dorado ditch, taking the water out of the latter at the Richardson ranch, several miles southeast of Mount Gregory, and carrying it through the village of Mount Gregory, down the Volcanoville Divide. Size, two feet on top, 16 inches at the bottom, and 18 inches deep. It was running water all summer during my stay on the

divide, as far as Mount Gregory This ditch is not in good condition, at the lower end being much overgrown with brush. The flumes and culverts are all in bad condition.

4. BOTTLE HILL DITCH.—Bottle Hill ditch commences at a point on the main Pilot Creek ditch, just below an old orchard, noted on the ditch plot, and runs down on the Bald Hill Divide, past Darling's ranch, to Bottle Hill Size, three feet on top, two feet at the bottom, and eighteen inches deep. It is dry; has not had any water in it since 1869.

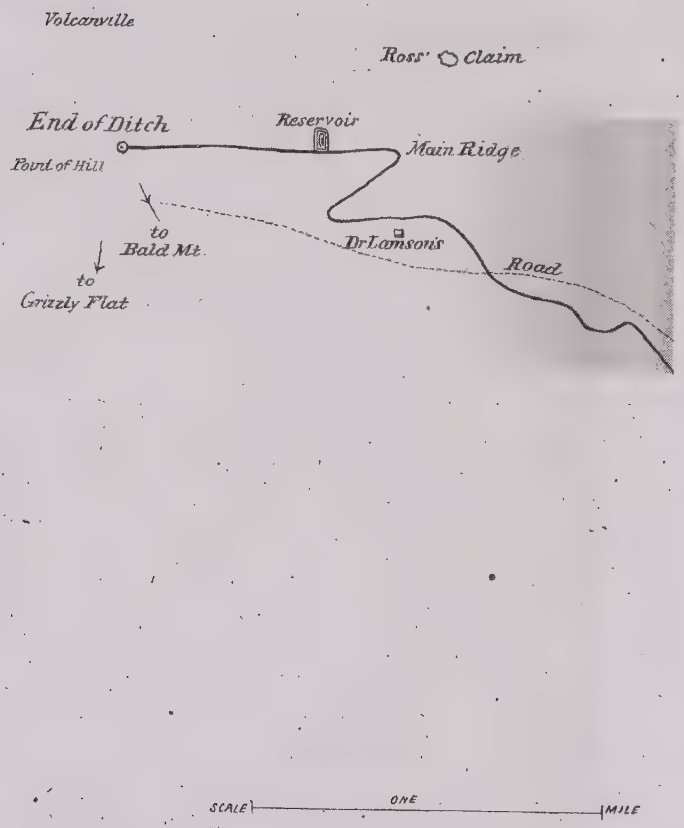
5. JONES' HILL DITCH runs from Bottle Hill to Jones' Hill, being a continuation of the Bottle Hill ditch, along the same divide, to its terminus. It has been dry for several years. Size, 2½ feet on top, 18 inches at the bottom, and 16 inches deep.

6. SCHLEIN ROCK CREEK DITCH, purchased with the Schlein diggings in 1873, runs from the head of Rock Creek, a short distance above the road from Works to Tunnel Hill, to Schlein's Diggings, at the southeast end of Tipton Hill. Size, about 18 inches wide and 12 inches deep.

7 CLIPPER CANON AND NEW YORK HILL DITCH, runs from Clipper Cañon to New York Hill. Size, two feet on top, 16 inches at the bottom, and 16 inches deep. It carries 140 inches of water.

8. THE SMALL NEW YORK HILL DITCH commences at a point on the main Pilot Creek ditch at its most northerly trend around Hotchkiss Hill, being the head of New York Hill spur, and runs to New York Hill, overlooking Cañon Creek. Size, 15 inches on top, 10 inches at the bottom, and 10 inches deep.

9. THE BLAISDEL HILL DITCH commences at the flume

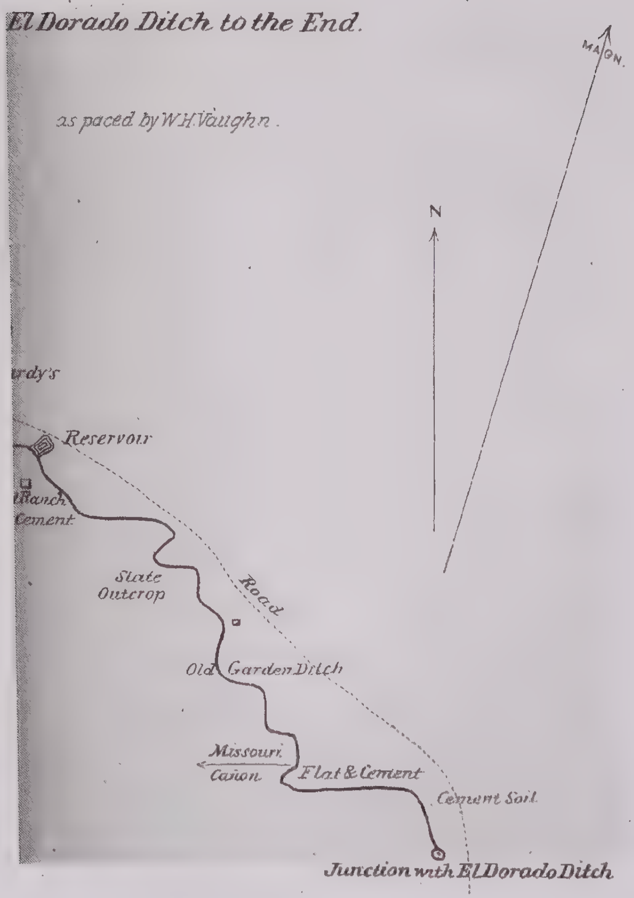

Volcanville
Ross' Claim
End of Ditch
Reservoir
Main Ridge
Point of Hill
to
Bald Mt.
Dr Lamson's
Road
to
Grizzly Flat
SCALE
ONE
MILE

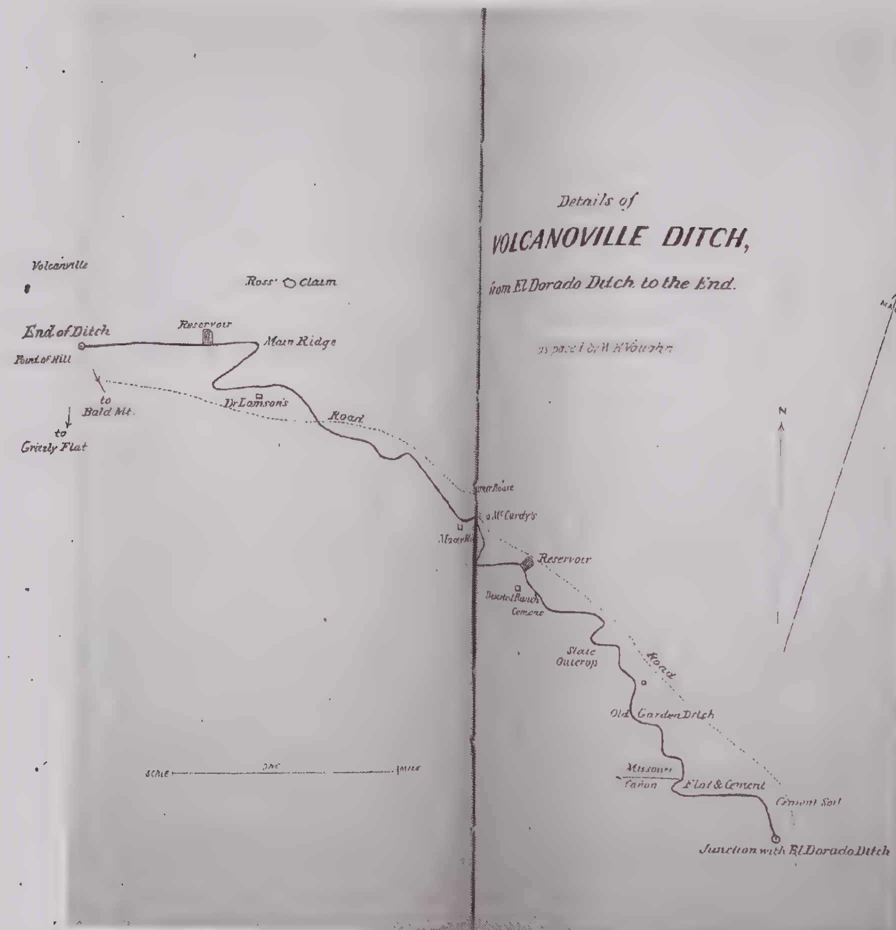
Details of

:CANOVILLE DITCH,

El Dorado Ditch to the End.

as paced by W.H.Vaughn.




Details of
VOLCANOVILLE DITCH,
from El Dorado Ditch to the End.
Volcanville
Ross' Claim
End of Ditch
Reservoir
Main Ridge
Point of Hill
to Bald Mt.
to Grizzly Flat
Dr Lamson's
Road
McCurdy's
Reservoir
Slate Outcrop
Road
Old Garden Ditch
Missouri Cañon
Flat & Cement
Cement Soil
Junction with El Dorado Ditch
N
Scale
Mile

near Mountain Tim's shebang, on the road between Georgetown and Hotchkiss Hill, and runs to the Blaisdell diggings. Size, two feet on top, eighteen inches at the bottom, and sixteen inches deep. It carries 300 inches of water; was dry in August, 1873, during my visit, but ran water last winter.

10. ROCK CREEK DITCH is a tributary to the main ditch, flowing into it between Tunnel Hill and Work's ranch. It starts out of Rock Creek near its source. The water in Rock Creek at this point on August 4th, 1873, was 30 inches. Size, three feet on top, two feet at the bottom, and eighteen inches deep. For one and a half miles at the upper end it was running 15 inches of water on the day mentioned; at the lower it was dry.

11. FAIR PLAY DITCH commences 250 paces above the "Chinese Camp," on the El Dorado ditch, on the ridge between Cañon Creek and Bear Creek, and runs along the divide between Bear Creek and Rock Cañon, to Cook's Ranch and Fair Play. Capacity, 150 inches. Its waters are tributary to Travers' Creek. Length, seven miles. The ditch is in good condition.

12. BEAR CREEK DITCH starts from Bear Creek, near Grey Eagle Hill, and runs to Gold Hill. Size, 20 inches on top, 14 inches at the bottom, and 16 inches deep. It is in a bad condition. Water has not been running in it for some time. A portion of it, near its head, was used last winter.

(c.)—LITTLE SOUTH FORK SECTION.

The LITTLE SOUTH FORK DITCH, in process of construction, takes the water from Loon Lake reservoir, *via* Gurley Creek, across Little South Fork, and along its left bank to its junction with the main Middle Fork of the American, and through a tunnel turns it into the

head of Pilot Creek Basin, at Frazer's Camp. Size, about six feet on top, four feet at the bottom, and three deep.

(*d*)—RUBICON SECTION.

A ditch survey has been made from the Rubicon River, a mile or two below the crossing of the trail to Lake Tahoe, along the left bank of the Rubicon or Middle Fork, to Gurley Creek, in the basin of the Little South Fork, a distance of about 19 miles. Any ditch along this route would be very difficult to construct, and costly. It is believed, however, that a shorter and easier route can be found.

From a point on the Tahoe trail, near Duck Lakes, a ditch or flume could be constructed, nine or ten miles in length, to the Rubicon, at a point about six miles above the Rubicon crossing of the trail to Tahoe, where as much water was observed to run in the bed of the Rubicon at midsummer, as at the initial point of the survey mentioned. This ditch or flume would empty the waters of the Rubicon into Loon Lake Reservoir.

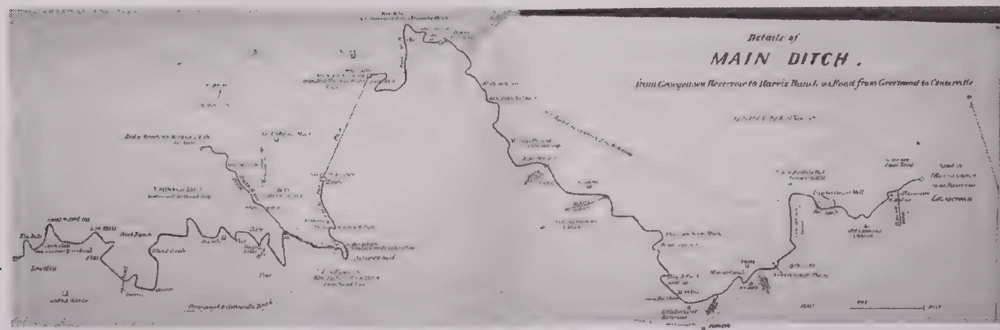
II—WEST OF GEORGETOWN.

(*a*)—GEORGETOWN, GREENWOOD, AND KELSEY SECTIONS.

The *Main Ditch* continues from the big reservoir at Georgetown, to Greenwood, crossing Greenwood Cañon by means of a pipe a mile in length, bearing 300 feet of pressure. Size of ditch, five feet on top, three feet at the bottom, and twenty inches deep.

BRANCH DITCHES IN THE GEORGETOWN-GREENWOOD SECTION

1. Mamaluke Hill Ditch begins at a point on the main ditch, near the big reservoir, where the main ditch crosses the Georgetown and Hotchkiss Hill road. Size,


Details of
MAIN DITCH.
from Georgetown Reservoir to Harris Ranch, on Road from Greenwood to Centerville

wo feet on top, sixteen inches at the bottom, and sixeen inches deep. It is in good condition; was running vater at the time of my visit, August 16th, 1873.

2. Georgia Slide Ditch commences at a point on he Mamaluke Hill Ditch, 400 feet east-northeast of Baldwin's corral, and runs to Georgia Slide on Cañon Creek. Size two and a half feet on top eighteen inches at the bottom, and eighteen inches deep. It is in good condition, and is constantly running water.

3. Kelsey's Ditch runs from Georgetown to Kelsey Reservoir. Size, 30 inches on top, 18 inches at the bottom, and 18 inches deep. Forty inches of water were running in this part of the way—for six miles. It is in good condition all the way through. The ditch was originally very easily constructed, in good ground.

4. Rock Canon Ditch takes the water out of Rock Cañon, and joins Kelsey's Ditch at the Falls. Size, thirty inches on top, eighteen inches at the bottom, and eighteen inches depth. There has not been any water n it for a long time, and it is now one half filled up with sediment from local washes.

5. Sailor Flat Branch of Kelsey's Ditch and Rock Canon Ditch starts at Mocks, and runs to Sailor Flat.

6. The Spanish Flat Ditch is another branch of the Kelsey and Rock Cañon Ditch, leaving it at American Flat, and running on the east side of the divide, above American Flat, to Spanish Flat, a distance of about three miles by the ditch.

7. The Crane's Gulch, or Upper Johntown Ditch, commences at a point on the main ditch, on the divide between Georgetown and Greenwood, known as Billy, Farris' Cabin, and runs along the east side of the ridge,

between Empire and Manhattan Cañons to Crane's Gulch, the Woodside Mine, Hart Mine, and the Castile Mine. Size, two feet on top, sixteen inches at the bottom, and eighteen inches depth. It is in good condition, and running water all the time.

8. Spanish Dry Diggings Ditch runs from the main Georgetown Greenwood Ditch, at a point a quarter of a mile south of Davis' Reservoir to Spanish Dry Diggings. This has been delivering water constantly to the companies owning claims at the Spanish Dry Diggings; but a short time prior to August 9th, the date of my visit, it ran dry from the general scarcity of water. Size, two feet on top, eighteen inches at the bottom, and eighteen inches depth.

9. Johntown Ditch starts from the junction of Manhattan and Empire Creeks, at Stony Point, and runs along the west side of Empire Creek, a quarter of a mile; thence crossing it to the east side of Johntown Creek, continues down to Sailor Flat, a distance of about two miles by the ditch. Besides these are:

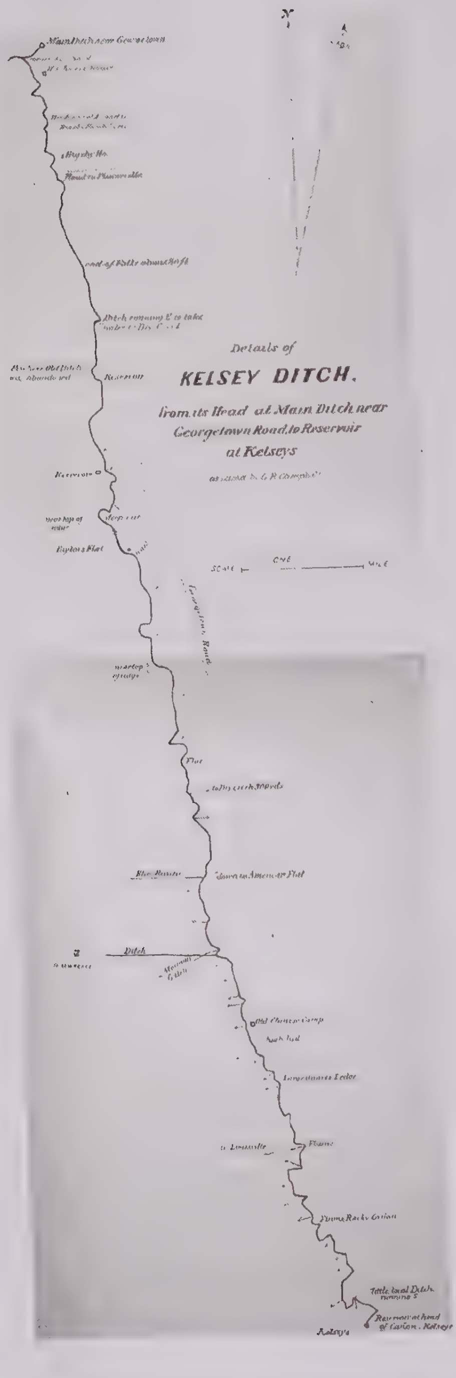
10. The American Mine Ditch running from the pipe tank north of Greenwood, N. N. W. to the American Mine.

11. McConnell Ditch, from McConnell's Ranch to Spanish Dry Diggings.

12. The Penobscot House Diggings Ditch, running from the main ditch to some diggings northwesterly from the Penobscot House.

13. The Coloma Ditch, from Dutch Creek to the American River, opposite Coloma.

The Coloma Ditch comes out of Dutch Creek about 300 feet from the river, and runs along the right bank of the South Fork of the American to Pleasant Flat,


Details of
KELSEY DITCH,
from its Head at Main Ditch near
Georgetown Road, to Reservoir
at Kelseys
SCALE
ONE
MILE
Main Ditch near Georgetown
Reservoir
deep cut
Flat
Ditch
Reservoir at head
of Cañon. Kelseys
Kelseys

reaching that point at an altitude 150 feet above the river; the distance being three or four miles. It is devoted to river bar mining and irrigation.

14. There are, in fact, three ditches along this route, all coming out of Dutch Creek. The California Water Company is interested in the other two also.

(b.)—MAIN DITCH—PILOT HILL SECTION.

The Pilot Hill (Centerville and Wild Goose) Ditch is a continuation of the main ditch from Greenwood to Pilot Hill, and runs to Ferguson's and Wild Goose Flat. Size, thirty inches on top, twenty inches at the bottom, and eighteen inches depth. It is in good condition. It was dry this season on August 11th; but water was run in it all last winter.

BRANCH AND DISTRIBUTING DITCHES, PILOT HILL SECTION.

1. The Old Wild Goose Ditch commences at a point on Knickerbocker Creek, near Hogg's. It runs its waters to a deep cañon called Cooper's Ravine, where the main Wild Goose or "Stone Ditch" crosses the cañon. From this point it runs parallel to the latter as far as Wild Goose Flat. Size, 20 inches on top, 14 inches at the bottom, and 14 inches deep.

2. Knickerbocker Flat Ditch commences about three quarters of a mile west of the Knickerbocker House, and one half a mile northwest of the road where it crosses the main ditch. It runs to the cañon, which empties it into Old Wild Goose Ditch. Size, 20 inches on top, 14 inches at the bottom, and 15 inches deep.

(c) —DITCHES OWNED BY VARIOUS PARTIES, OTHER THAN THE CALIFORNIA WATER COMPANY.

THE AMERICAN RIVER, OR REAMER, DITCH takes a large body of water out of the American River near the Auburn-Georgetown bridge, and carries it to Mississippi Bar and other points within 12 miles of Sacramento City. At the upper end, where the water is taken out of the river; (Tarnaroo Bar), the size is about 9 feet on top, 5½ feet at the bottom, and 4 feet depth. It is quite a canal; very substantially built, with rock walls for a distance of one mile. Thence, downward to Mississippi Bar, two or three miles below Folsom, it is five feet on top, two or three feet at the bottom, and three feet depth. The dam in the bed of the American River has been swept away again and again; and the property has been unavailable to a considerable degree and has suffered in consequence. During the past summer Reamer & Co. have been putting in a very substantial dam, which is well engineered, and, it is believed by them, will be permanent.

Among the ditches on Georgetown Divide, not owned by the California Water Company, those noted were:

1. BARKLAGE JONES' HILL DITCH, which takes the water out of the head of Otter Creek, near the Wilkins place at Kentucky Flat, draining the country between Work's ranch and Mount Gregory, and carries it down Little Bald Mountain Divide to Pilot Hill and Jones' Hill. Size, 18 inches wide by 14 inches deep.

2. THE BARKLAGE GEORGIA SLIDE DITCH takes the water out of Cañon Creek near Darling's Ranch, a little above the crossing of the Georgetown trail. Size about one foot by one foot.

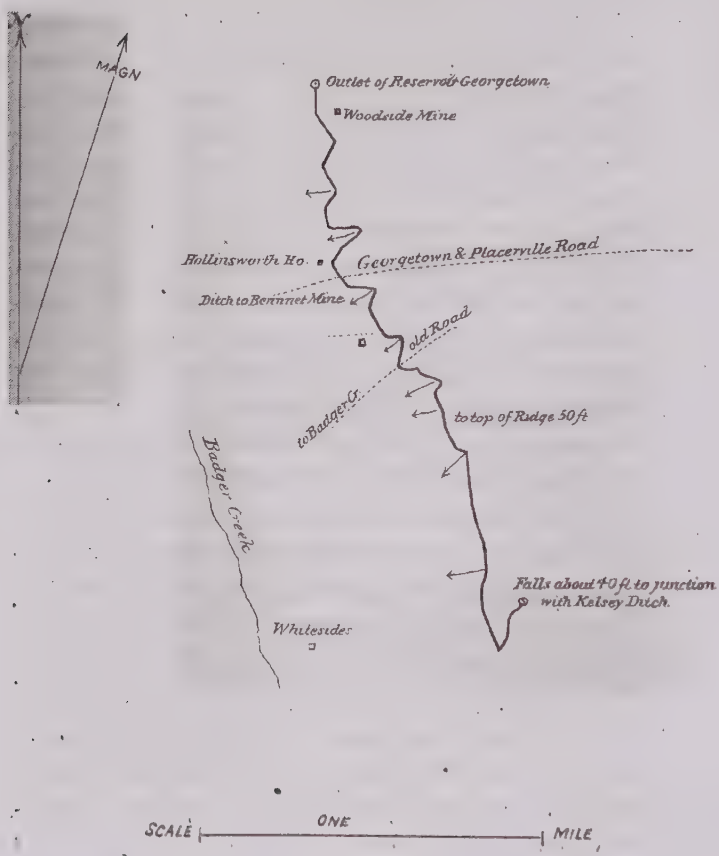
3. HINE DITCH, Spanish Dry Diggings, takes the

BRANCH OF

KELSEY DITCH

from outlet of Little Reservoir E. of Georgtown to main Kelsey Ditch

as paced by G.H. Campbell.



water out of Cañon Creek, near an old mill site below Georgia Slide, three miles above Spanish Dry Diggings, and carries it to Spanish Dry Diggings; and Hine's seam Diggings, $1\frac{1}{2}$ miles farther west. Size, about 20 inches wide by 15 inches deep.

4. THE SLATE MOUNTAIN DITCH is an irrigating ditch owned by Dickinson and others, on the divide between Rock Creek and Slate Creek; obtaining its water from a branch of Gaddes Creek.

5. There are numerous other small local irrigating ditches, most of which were originally constructed for mining purposes.

6. On the PLACERVILLE DIVIDE, is the extensive ditch system of the South Fork Company, of which F. A. Bishop is the engineer and superintendent. These ditches are partly represented on the accompanying map.

7. On the FORREST HILL DIVIDE, a mining country of extensive resources, there is not completed any general system of ditches connected with a summer supply of water, and mining as an industry consequently holds a place far below its true merits. The cañon of the Middle Fork, between Forrest Hill divide and Georgetown divide, is about 1,500 feet deep. Hence it is not beyond the bounds of possibility, under modern hydraulic engineering, to deliver water to Forrest Hill and Todd's Valley, or even to Michigan Bluffs, from the El Dorado Ditch, at the "Horn," or Mount Gregory. [For Mining Resources on Forrest Hill Divide, see under Mining.]

5.—MEASUREMENT—MINERS' INCHES.

Water is measured or delivered by the California Water Company by the customary square inch apera-

ture, under a pressure of six inches, making one inch equal to 94.7 cubic feet per hour.

In other localities, the pressure used is 10 inches, making 109.1 cubic feet per hour, as calculated.

The average of the miner's inch in California is, then, about 100 cubic feet per hour, or 1,000 cubic feet per day of 10 hours. The average price is ten cents per 1,000 cubic feet; equal to a cube or tank of 10 feet, measured either way.

For purposes of comparison with quantities elsewhere, I would suggest that the pressure or gauge of the water agent should be so regulated, in general, as to deliver *the average of one hundred cubic feet per hour.*

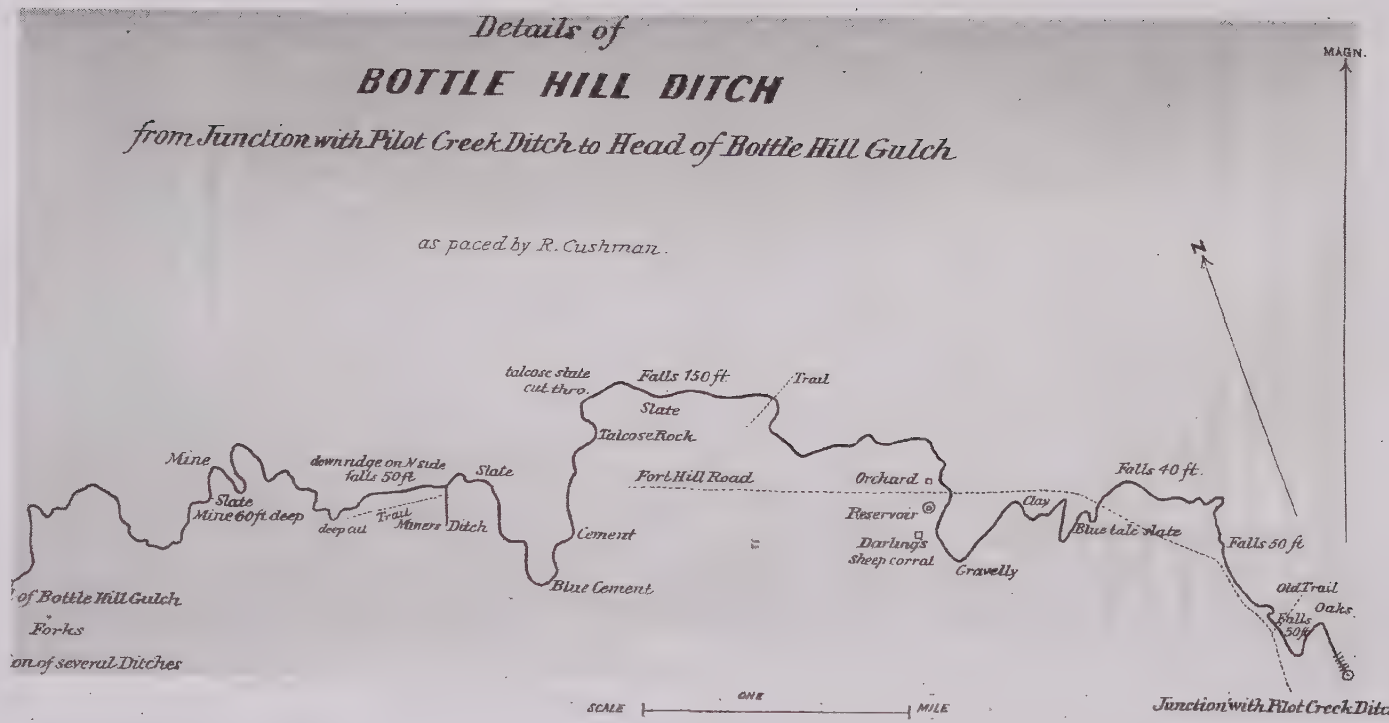
This would be equivalent to 10 cubic feet, or a trough 10 feet long, one foot wide, and one foot deep, in six minutes; equal to one cubic foot, or a *very large* bucket, in 36 seconds. The cubic foot contains 6.23 gallons.

The increased proportion of water flowing when there is a large amount taken, may be allowed in the place of the inducement customarily offered in favor of wholesale purchases.

THE STANDARD MINER'S INCH.

Pressure from surface to top or middle of orifice (varying.)	Miner's Inch.	In Cubic Feet (each 6.23 galls.)				AUTHORITY.
		Per Sec.	Per Min	Per Hour	Per 24 Hrs.	
6 inch pressure.	1	.039	2.33	140	3360	Hittell.
" "	1	.026	1.57	94.7	2274	Carpenter.
" "	38	1	60	3600	86,400	Carpenter.
" "	1000	26⅓	1580	94,700	2,274,000	Carpenter.
10 inch pressure.	1	.03	1.8	109.1	2618	Carpenter.
6 to 10 inch pressure.	1	.027	1.6	100	2400	*Standard*
" " "	10	.27	16	1000	24,000	experimental
" " "	100	2.7	166.	10,000	240,000	Miner's Inch.
" " "	1000	27.	1666	100,000	2,400,000	

ESTIMATION OF QUANTITY OF WATER OBSERVED FLOWING IN STREAMS.—The following is the basis on which estimations were made of the quantity, in miners' inches,


Details of
BOTTLE HILL DITCH
from Junction with Pilot Creek Ditch to Head of Bottle Hill Gulch
as paced by R. Cushman.
MAGN.
N
talcose slate cut thro.
Falls 150 ft.
Trail
Slate
Talcose Rock
Mine
down ridge on N side falls 50 ft.
Slate
Slate
Mine 60ft deep
Trail
deep cut
Miners Ditch
Fort Hill Road
Orchard
Reservoir
Darling's Sheep corral
Clay
Gravelly
Falls 40 ft.
Blue talc slate
Falls 50 ft.
Old Trail
Oaks.
Falls 50 ft
Cement
Blue Cement
of Bottle Hill Gulch
Forks
on of several Ditches
SCALE
ONE
MILE
Junction with Pilot Creek Ditch

of water observed flowing in streams crossed during my stay on the divide:

The breadth, depth, and velocity of the stream, in feet per minute (as traveled by a chip), were estimated by the eye. The sectional area being reduced to square feet and decimals thereof, we have multiple x 60 = the cubic feet per hour. Divided by 100, or moving the decimal point two places to the left, = the miners' inches. Or, *observe* 6 *seconds*, and distance x area x 6 = miners' inches.

6.—EVAPORATION AND SEEPAGE.

In England, the amount due to evaporation and absorption ranges from nine to nineteen inches per annum. In ordinary mountain districts, fourteen inches. In some instances evaporation and seepage are found as high as twenty-five per cent. of the rainfall. The nearest approximation to a rule is to allow *one sixth* for water which cannot be impounded.

Rate of flow.

1. Altitude under Two Thousand Feet—Georgetown to Pilot Hill.—Between Greenwood and Wild Goose Flat, during the summer season, according to the observation of Mr. Jones, Water Agent, water turned on at the former place at 6 P. M. reached Pilot Hill in twelve hours, and Wild Goose Flat in eighteen hours; the distances being sixteen and twenty-five miles by the ditch, respectively. The water accordingly flowed at the rate of one and one third miles per hour, or 111 *feet per minute.*

Loss, delivered 35 per cent.

The quantity turned on in this case was 100 inches; of which thirty-five inches only reached Pilot Hill; in other words, only *thirty-five per cent.* It was run during the night time.

Mr. McKusick states that on one occasion, not in the

dry season, upon measuring, it was found that out of seventy-five inches turned into the ditch at Georgetown, seventy inches reached Pilot Hill.

Loss 20 per cent

In summer, during the dryest season, with an interrupted flow of water in the ditches, there is a loss of about one *half*. But when there is a steady flow in the dryest season, the loss does not exceed *twenty per cent.* In winter, the evaporation and seepage amount to little or nothing. During three fourths of the year, the addition of water from tributary ravines makes up for more than is lost by evaporation and seepage.

Delivered two thirds.

2. Altitude from Two Thousand Five Hundred to Four Thousand Feet — Georgetown to Pilot Creek Reservoir. — From Pilot Creek Reservoir to Georgetown, the loss, especially in summer, is heavy. In the upper portion, the ditch runs for several miles through a "cement country," where there is an unusual amount of seepage. Mr. Gorman, the Ditch Agent, says, the water "does not get to Georgetown." Out of 300 inches turned on at Pilot Creek Reservoir, in one case, according to Mr. Gorham, only 160 to 200 inches reached Georgetown; in other words, about *two thirds.* But there would not be that much loss in any case, when there is a full supply of water running in the ditch. The greatest loss is when the ditch is about half full at its head. With a full ditch, in summer, the loss from evaporation and seepage on this section probably does not exceed *twenty per cent.*

Av loss not over 20 per cent

15 inches.

Fifteen inches of water observed flowing at the head of Rock Creek Ditch, failed to reach its end, or the debouchure of the ditch into the main Pilot Creek Ditch.

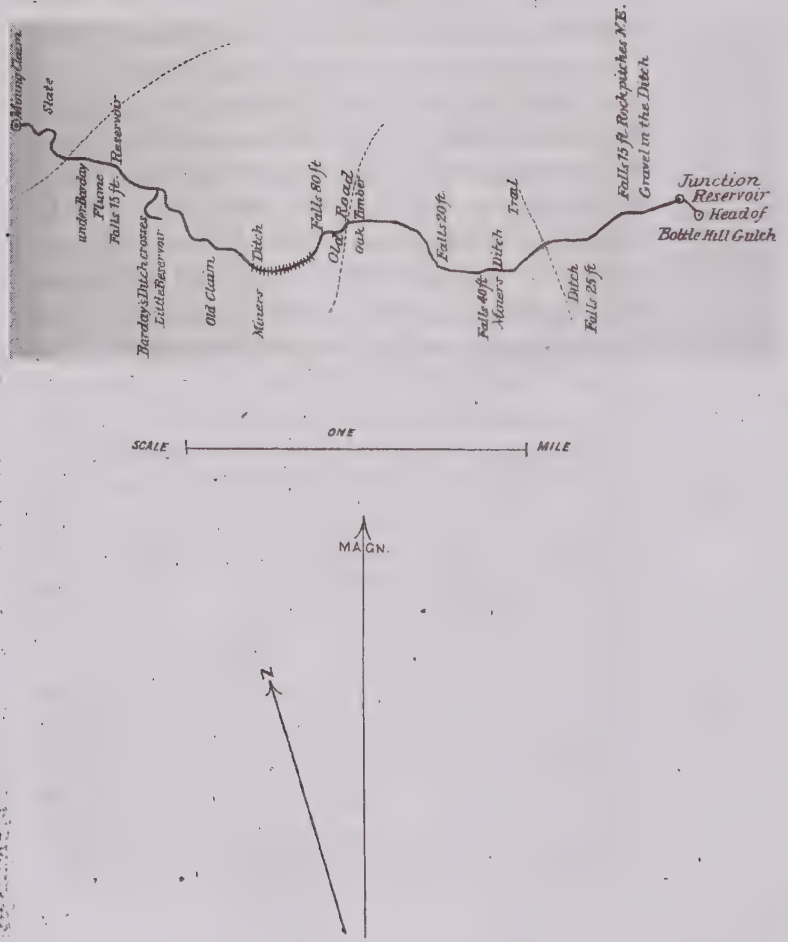
Only about three fourths of the water let into the Pilot Creek Ditch, at Pilot Creek Reservoir, is believed, by some of the ditch employes, to reach Georgetown.

Details of

DITCH

FROM JONES HILL TO BOTTLE HILL

as paced by Robert Cushman



3. ALTITUDE FROM FOUR THOUSAND TO SIX THOUSAND FEET.—The evaporation of the surface of Loon Lake Reservoir, during the season of my visit, as represented by the receding water line, at the edge of the lake (which may include, perhaps, a small amount of seepage), was sixteen to eighteen inches. On a lake surface

7.—APPLICATION OF WATER TO MINING.

Water is sold by the California Water Company for mining in the following districts: Georgetown, Georgia Slide, Pilot Hill, Crane's Gulch, Mt. Gregory, Volcanoville, Tipton Hill, Spanish Dry Diggings, Greenwood, St. Lawrenceville, Kelsey's, Rich Flat, Centerville, Wild Goose, and along the South Fork of the American, to ranches mostly. Districts

The French claim, or Nagler Company, at Greenwood, has paid a total of \$20,000 to \$30,000 to the Water Company; at the rate of \$120 a week, for a long time. The average rate was more nearly \$80 a week, running two thirds of the time through the year. Example.

EXECUTION.

Hydraulic Mining on Georgetown Divide is confined chiefly to the seam diggings. These consist of decomposed or slightly metamorphosed slates and shales, trending in belts in the strike of the country rock, as represented at several points on the map. The country rock has become so soft as to be easily removed in many places with the pipe; but in other localities this can only be done to advantage with the aid of blasting: Harder spots are met with, it is true, which are removed with little difficulty without blasting, as the rock crumbles into the sluices, and is carried away with the aid In the seam diggings.

of larger quantities of water and an unusually high sluice grade—20 inches to the box.

A "head."

Under such circumstances the execution of an inch or a "head" of water, is necessarily very different from rates observed in gravel mining. For purposes of comparison, I have made the following figures:

Will move ⅓ its weight

IN GRAVEL MINING, 800 inches at 100 feet "head," working for ten hours = 800 ten-foot cubes of water = 800,000 cubic feet, weighing 24,880 tons (without adding thereto the pressure arising from the "head" employed), will move through ordinary sluice-grades of eight to twelve inches to the box, 3,000 cubic yards of loosened gravel, or 2,000 cubic yards of ordinary uncemented bank gravel; say an average of 2,500 cubic yards, weighing 8,300 tons; or $(\frac{24880}{8347}) = \frac{1}{3}$ of the weight of water employed.

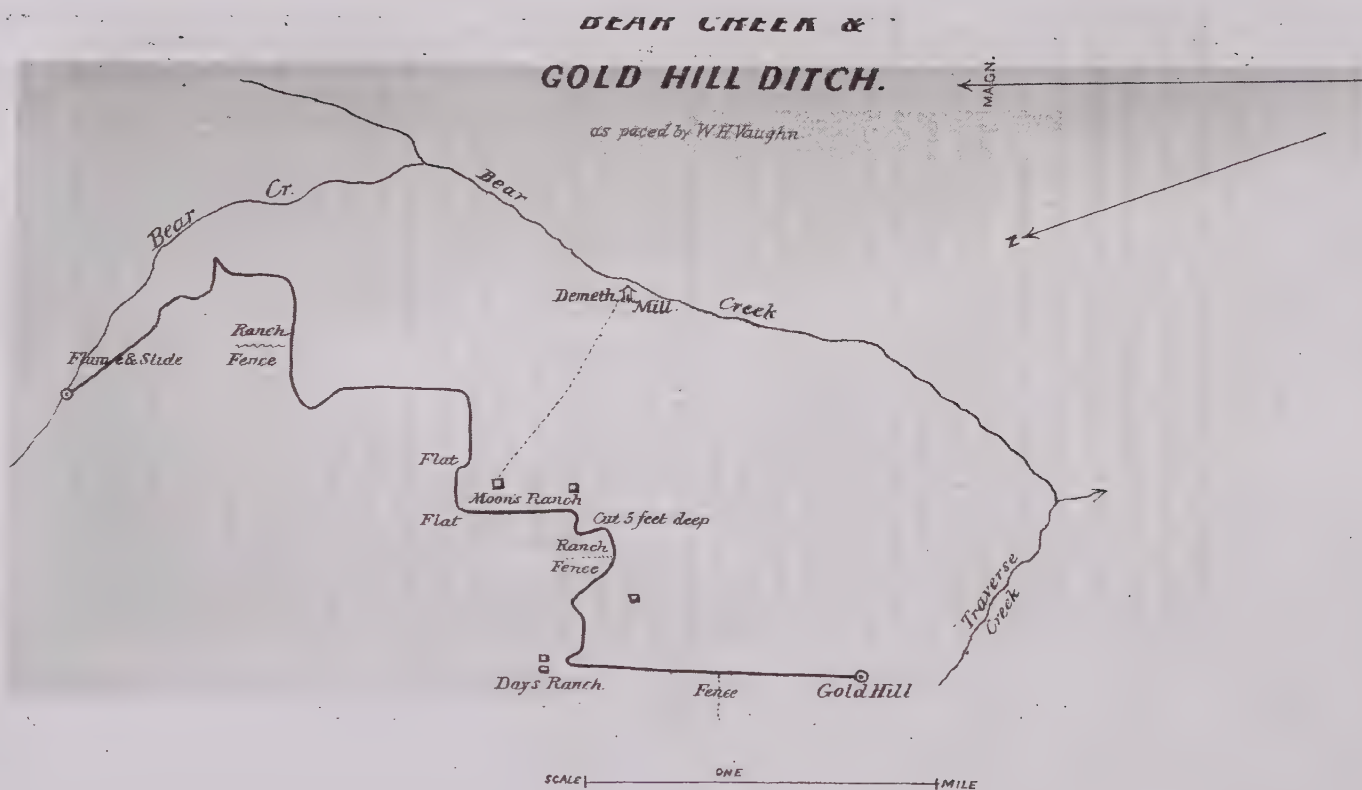
In yards, 3 times the inches.

Reckoned by inches, the amount of gravel moved = *three times* as many cubic yards as there are miners' inches employed.

WEIGHT OF WATER.—A cubic foot of water at 62° Fahrenheit, weighs 62.321 pounds. One thousand cubic feet (10x10x10) equals, accordingly, 62,321 pounds, or 31.160 tons.

The weight of gravel, sand, rock, etc., is exhibited in the following table.

	Pounds in a cubic foot.	Pounds in a cubic yard.	Spec. grav., water being equal to 1.
1—Clay	120	4,800	1.92
2—Sand, dry	88.6	......	1.42
3—Sand, wet	118	......	1.9
4—Trap Rock	170	4,590	2.72
5—Basalt	187.3	5,060	3.
6—Quartz	165	4,450	2.65
7—Shale	162	4,370	2.6
8—Slate (clay)	180	4,800	2.9
9—Decomposed Shale (estimated)	100	2,700	1.8


BEAR CREEK &
GOLD HILL DITCH.
as paced by W.H. Vaughn
MAGN.
N
Bear
Cr.
Bear
Creek
Demeth Mill
Flume & Slide
Ranch
Fence
Flat
Moons Ranch
Flat
Cut 5 feet deep
Ranch
Fence
Days Ranch
Fence
Gold Hill
Traverse
Creek
SCALE
ONE
MILE

THE COST of water for moving a cubic yard, at 10 cents per inch, equals $3\frac{1}{3}$ cents per yard. The total estimated cost of moving a cubic yard of gravel, including labor and mining, generally equals (according to Carpenter, late Secretary of the Excelsior Water Company) 20 cents; leaving 16 cents as the amount to be attributed to other costs than water, in the prosecution of hydraulic mining. Per cubic yard.

APPLIED TO SEAM MINING.—The principal difference in the execution of water in decomposed shales, of which No. 7 in the above table may be taken as the representative, compared with the execution in gravel mining, arises less from the difference in weight and specific gravity of the material, than from the *angularity* of the rock in the instance under consideration. The gravel boulders, being round, are lifted up and slidden over each other by the aid of the specific gravity of the water. Greater friction.

I was not able, from want of time, to make any close calculation of the amount of water required, on the average, to move a cubic yard of shale or decomposed slate under these conditions, nor of the exact yield corresponding to ground removed. Probably the amount of water used to move the same number of cubic yards of shale would be found, in many cases, to exceed that employed in moving gravel *from* 10 *to* 20 *per cent.* In other (less frequently occurring) cases, like that of the St. Lawrence seam mine at Greenwood, the execution would be fully up to that in easy gravel. Proportion.

PERMANENCY OF SEAM MINING BY THE HYDRAULIC PROCESS.

Under limited conditions, water, under a high pressure, as applied to seam mining, operates advantage- Concentrated surface dirt.

ously. These conditions are referred to under III. and VIII, where the possession of water is shown to be an efficient agency for prospecting, and for acquiring valuable mines, by hydraulicing away the surface dirt on the seam belts.

Water, in fact, is the essential agency of prospecting. Without it in the seam mines nothing can be done, even to amount to a tolerable prospecting.

Permanent working

But as a means of continuous mining, or anything further than introductory work, water in the seam mines encounters *two difficulties* not met with in hydraulic mining.

Pay.

1. The pay, when struck, *does not continue* horizontally in daylight. Its continuation is into the narrow, dark and inaccessible interior of the earth. Wherever the pay is found, thither the miner with all his appliances and his ingenuity must follow.

Sluice grade

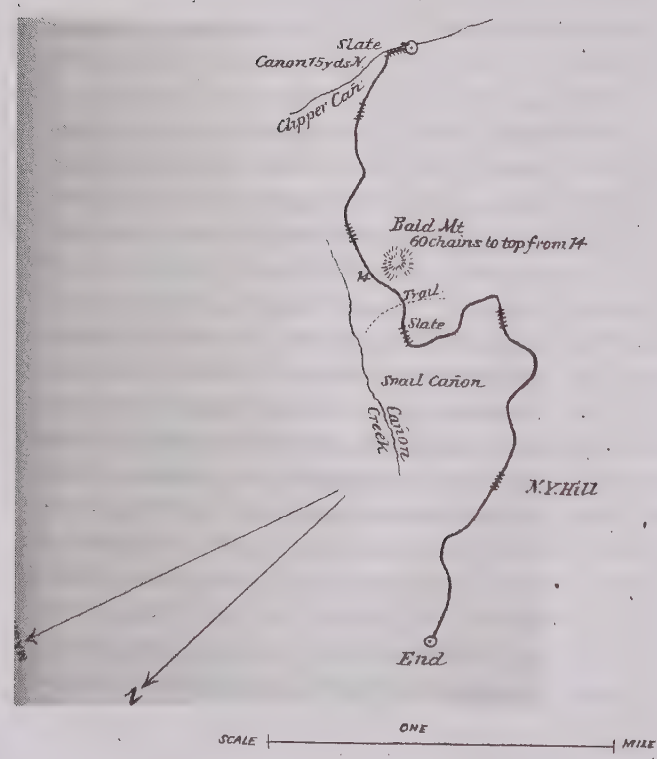
2. In seam belt mining, the sluice grade is in every instance considerably greater. A grade of eight inches to 12 feet would take the miner from his outlet in the valley up a mountain of 300 feet in a mile. A grade of 16 inches to the box would carry him up 600 feet in the same distance. Except for local and limited undertakings, in the character of prospecting, hydraulic mining must be considered as temporary, and as an initial or intermediate proceeding to more methodical and thorough-going work, where the ground has been proven to be first-class mining ground.

So long as the conditions of hydraulicing continue to be favorable, however, it cannot be gainsaid that this kind of work on the seam belts is effective, economical, and that it frequently promises very great rewards.

Details of

CLIPPER CAÑON DITCH

as paced by W. H. Vaughn



9.—POWER, ETC., FOR MINING AND MILLING PURPOSES.

The Cedarberg Mill was receiving 8 inches of water for battery purposes when I visited it. The St. Lawrence Mill was receiving 10 inches of water for its battery, although the company had contracted for a little more. In neither of these cases is water used for power. They are mentioned as suggestive of what might be done with water on the seam belts in ways other than hydraulicing. Supposing that the common operations of hydraulicing on any portion of the seam belts have proven *a success*, there must necessarily follow, as elsewhere intimated, three consequences: Common milling

1. Rich pay is struck, which continues, not horizontally along the surface, but down into the bowels of the earth; Underground operations

2. The pay dirt will very soon be piped off, and you will be hydraulicing in country rock; or

3. If the pay dirt should be continuous for some distance, the high sluice grades necessary in seam hydraulicing will soon lead you with your sluice inlet into the sky. Now begins mining in earnest. If you have discovered and definitely located a rich mining deposit, you must follow it by the ordinary processes of underground mining.

The water you have been using under a high pressure for placer hydraulic mining will now come into play to meet and obviate the two grand *initial drawbacks*, the necessary preliminary outlays to permanent underground mining.

The cost of underground mining is not so much the cost of sinking, and the excavating of tunnels, levels,

and stopes, as it is getting rid of the material excavated. Obviously, if you had your pay ore above ground where you want it, the loosening operations alone would be but trifling.

For Hoisting and Pumping, your water in pipes under pressure may be used in some cases without destroying its usefulness as a placer washing agency. Your power may be taken from the pipe at a point as near to the head as would yet afford you the necessary power. The execution of both water and pressure below that point, would remain at your disposal for other purposes.

The means of *communicating* your power from that point to any other desired point are simple, durable, and economical. (See Hallidie's Wire Rope Pamphlet for 1873.) Should you become convinced from the experience of others that you can work engines or machinery without vaporizing your water, and obtain the same amount of pressure, you would realize that you have in the possession of power a means of continuing mining operations under ground under highly favorable conditions. I will merely mention in this connection the fact that, besides the turbine and hurdy-gurdy, the water engine, operating like steam under pressure, is a perfected machine which has been successfully employed in other countries for many years.

For drawings of good working machines, I refer you to "London Engineering," 1870–3; and for a California model, to the Howe Sewing Machine Co., Kearny st., San Francisco. A collosal engine of this sort has been at work in the mines at Freiberg, Saxony, for 20 years or more. (See *Concentration of Sulphurets,* Sub. VIII.)

Ditches as a Means of Transportation.—Ditches can be taken advantage of for the purpose of transporting mining timbers to the mine; so that when operations

are continued under ground, timbering will cost little more than the item of cutting timber.

10.—APPLICATION TO AGRICULTURE.

Your water may be applied to Agriculture in three different ways, entirely distinct in their policy.

1. Sale of water to agriculturists.

2. Application to agricultural lands owned by the company.

3. Sale of water for a certain share in the proceeds, or sale of the company's stock, so that the agriculturist may participate in the management, and dividends of the company. In either case, a practical community of interest.

Cases two and three are elsewhere referred to. Concerning case one, Mr. Jones thinks he could now collect $1,000 per annum, from twelve or fifteen farmers residing below Greenwood.

Small returns.

The proportion of water sales hitherto at Georgetown, Greenwood and Kelsey's to agriculturists has been very small; indeed, been too trifling to be worth mentioning. Parties requiring two, four, and ten inches for a few months during the dryest season, were the only takers. There is not enough income from this source to pay for the trouble of measuring and collecting. The total water sold for irrigation during the dry season is under $500.

Farmers' talk.

Agriculturists generally talk a good deal to this effect: that if they were assured of a constant supply, at reasonable rates, they would sow alfalfa, and raise three or four crops in the course of the year, and so be able to take and pay for a considerable quantity of water.

These and other like propositions should, and undoubtedly will, receive the fair consideration of the

stockholders and directors of the company, at their annual meetings.

Disappointments. Where parties have heretofore undertaken to put in from four to fifteen acres of clover, as during the past season, they can only be said to have been a little premature, because the Little South Fork ditch, connecting with Loon Lake reservoir, had not been completed. The season having proved unusually dry, while the water company was bound by contracts, as well as by policy, to supply the quartz mills, where water was being taken day and night the year round, of course these isolated agriculturists had to be disappointed.

It is an important consideration to the farmer who plants a crop or starts an orchard, to know whether his water supply in any dry season may be liable to be cut off, and his labor and property consequently forced to go to ruin.

Experience. The extent to which agriculture may be followed successfully by *respectable populations* in the foot-hills and in the mining regions is not yet fully developed. In a few localities on other Divides there have been profitable results. I can only refer to the horticulturists of Coloma and Placerville; to the Natoma Ditch Company's operations, based upon the policy of using their own water on their own land; to the Auburn and Newcastle vineyards, in connection with railroad transportation; to the experiments of the hay and strawberry farmers at Smartsville; and to the vineyard of Pauline on the Upper Honcut and others situated on the road between Marysville and La Porte, Sierra County; to the experience of the migratory stock-rangers of the foot-hills and of the high Sierra, etc.

Substantial. Enough has been done in these localities, and by methods here suggested, to demonstrate beyond a

doubt the existence of substantial agricultural *capabilities* in this region, of a very respectable character. Whether you may prefer to utilize these directly as a company, collectively or individually, the fact of development implies that the first share of the profits is to go to the water company.

Development means profit.

The agricultural interest in the mountains, notwithstanding its promises and the unquestionable attractiveness of the climate, is despised by all capitalists whose money is invested in mining. Ideas

The California Water Company will find it necessary, in order to stimulate agriculture and horticulture on Georgetown Divide, to create its own market in this direction by *developing capabilities*, tempting people to locate, initiating practicable methods, and pointing out results in order to induce, if not immigration, at least to prevent a further emigration and depopulation. Water market.

The Quantity of Water required to irrigate an Acre varies considerably, depending chiefly upon the crop. Vines require very little; none after they are rooted. Other fruit requires irrigation. An inch of water running night and day will irrigate from *one to ten acres* for some products For grass and clover, 10 inches, running three days in the week (of 24 hours each), would irrigate ten acres. Perhaps a constant flow of five inches to every ten acres would be near the mark; in other products one half an inch to the acre. Grass, clover, fruit.

The few results I have obtained, as examples, of the quantity of water required to irrigate an acre, may be stated as follows:

For Hay, one inch to half an inch per acre, running night and day.

For Berries and newly planted Vines, one half to one quarter inch per acre, running night and day.

For Trees, one quarter to one tenth of an inch per acre, running night and day.

Acreage controlled.

The question of greatest importance to the Water Company is: Given a certain quantity of water which may be diverted during the dry season to agriculture; how large a country in acres will it supply? And what amount of country, or crop, so supplied, can afford to pay the largest price for water?

Diversion to agriculture.

POLICY DURING THE DRY SEASON.—It should be the policy of the Water Company to divert to agriculture every inch of water that can possibly be done during the dry season, without real detriment to the mining interest. Agriculture being permanent, with permanent demands for water, it is worthy of this consideration.

The abundant winter supply of water may be depended upon to do most of the heavy work necessary to be done by water in mining. As the agriculturist prepares in winter for more energetic operations in the summer, so should the miner prepare in summer for his more energetic operations in the coming winter.

LAND.

Adapted to operations.

There is any quantity of land to be had at $1.25, $2.50, and $5.00 an acre, suitable for stock ranges, in connection with fruit, and nut orchards, vineyards, and plantations for berry culture, etc. The valleys are usually narrow; yet, large enough, and not unsuitable for this kind of farming. About one half of the soil of the hills is uninviting for any purpose other than for stock ranges. But with the aid of fencing, and alternation in grazing, the latter interest, aided by a little

irrigation—say, of twenty to forty acres to every 600—would flourish extensively.

11.—FOR CITY SUPPLY.

Sacramento is situated opposite the west end of Georgetown Divide. The city is supplied with water by pumping from Sacramento River. "Holly's system" of pumping, which has been adopted recently, consists in forcing water into the pipes with such a pressure as would equal the effect of a head of 100 to 150 feet from an elevated reservoir, for which there is no ground in the vicinity. Force pumps.

COST OF RAISING WATER FOR CITY SUPPLY.—Data on this subject were published from time to time in the Sacramento *Union* during 1872–3, before the introduction of the Holly works. In December, 1873, water was pumped for two weeks at the rate of 870,458 gallons per day, with 1,573 lbs of coal and three cords of wood per day; the column being 165 feet, and the degree of domestic pressure thirty pounds to the square inch. The population of Sacramento is about 16,000. Data for comparison.

The commissioners of inquiry, concerning town supplies in England, reckoned the cost at 0.358 to 0.150 pence to raise 1,000 gallons 100 feet. The lowest estimate was one shilling to raise 80,000 gallons 100 feet.

The cost of water to individual consumers in Sacramento, under the Holly system, has increased over that of the former system, which consisted in simply raising the water to a tank. Houses now pay from $1.50 to $2.50 per month.

The greater economy of water from the mountains will be the inducement in future for the adoption of the Aqueducts and pipe

"ancient and approved" natural system of supply. It is no longer necessary to build the enormous aqueducts characteristic of ancient cities. The Iron Age has furnished a simpler and cheaper means of conduit in wrought iron pipes, and the quantities which may be supplied with economy under such a system corresponds more nearly with the wants of a city which is destined to flourish in the arts, in civilization and manufactures in years to come.

Advantages

The demand for water to irrigate in and around a large city is extensive, and the price paid for such purposes is correspondingly large. A plan relating to this subject is recommended to your attention elsewhere, (VIII.) Such a plan, if adopted, would place your company in a better position to supply Sacramento with water than any other ditch company existing, for several reasons.

1. The ditches would be completed without further outlay to a point ten or twelve miles from Sacramento, sufficiently elevated to command the highest buildings that can be erected in Sacramento.

2. Your supply would not be subject to any possible future admixture of impurities from mining at your sources of supply.

3. The amount of water at your disposal in the dry season, when water is most wanted in the valley, would be unlimited.

12.—SAN FRANCISCO WATER SUPPLY.

Supply
Main pipes

The Spring Valley reservoir, at San Andreas Valley, San Mateo County, holds a reserve supply of one billion gallons of water. The dam is completed, faced with cobble stonework inside, and constructed with a

view to permanence for centuries. The flowing water is brought from a great distance down in the San Mateo Coast Range, and about all the available sources within reach south of the Golden Gate are tapped for the benefit of the metropolis. The Market street main, however, is only eight inches in diameter, and such streets as Montgomery and Kearny have only six-inch mains, while on other streets, the pipes are from two to six inches; a size, independently of the supply, inadequate to meet the necessities of great fires and other like emergencies.

But the Spring Valley Company is the most merciless of all monopolies; and they have so hedged themselves that there appears to be no recourse left to San-Francisco, other than the inauguration of another scheme of water supply. Monopoly

If the people of San Francisco can not purchase the Spring Valley works or Lake Merced at a moderate figure, they will be forced to look to the Sierra Nevada; and the California Water Company is believed to be in a better position to offer both Sacramento and San Francisco an unlimited water supply than any other company yet organized. Project.

Beside Von Schmidtz's Lake Tahoe project, there is a similar one set on foot by W. B. Clarke, of Calaveras County, who proposes to bring water to San Francisco from the head of the North Fork of the Mokelumne river. The length of pipe required by him, *via* Livermore Pass or San Jose, would be about ninety miles.

13.—APPLICATION TO MANUFACTURES.

What is said in regard to power for mining purposes applies equally to the power required for manufactures,

whether in the forest region on the western slope of the Sierra, or the growing requirements of Sacramento.

At Sacramento.

Sacramento is situated at the head of tide water. Were it possible to furnish it with cheap water power, that city would soon develop a variety of manufacturing interests. Without entering here into any calculation of the loss of head which would result from friction, in from 12 to 18 miles of pipe, or to the possibility of of carrying in pipes under great pressure a sufficient amount of power to make this item an object of business consideration, I merely call your attention to the fact that the water used for power at Sacramento would not be lost, but would still supply the city in the same manner as if the power had not been used; and that under such situations where the water would not need to be, or could not be easily continued in the pipes after having been used for power, it could be applied to irrigation directly in the neighborhood of the city. The American River will never answer for this purpose, because it is too intermittent; in summer it is sluggish, in winter it is unmanageable.

This would be simply taking the power of a fine mountain stream (though artificial) from a point nearer to Sacramento than Folsom, and, by means of a pipe ten or fifteen miles in length, applying it in the city, where both the power and the water are wanted *ad libitum*, and where there is money to pay for the same.

Sacramento's problem.

The benefit to Sacramento of such an arrangement, if practicable, would of course be incalculable. If from your pipes you can transform a pressure equal to that of steam in a steam boiler into power, by means of the water engine—the application of old and simple mechanical devices—you will have solved the problem of furnishing manufacturing power for Sacramento.

Friction head and pressure.

It should be remembered in this connection that the friction arising in the pipe in so great a distance would operate only as a loss of head. In other words the pressure in the pipes at Sacramento would be reduced exactly in proportion to the loss of head by friction. Wrought iron pipe, to bear from 300 to 500 feet head pressure, could be laid into Sacramento City without any difficulty, or mechanical drawbacks whatever.

VI.—OTHER RESOURCES.

Independent industries.

The agricultural, timber, and manufacturing resources of Georgetown Divide have been touched upon heretofore only as corollaries to the application of water, and the development of mines. Something should be said concerning them in this connection as independent resources, or the foundation of present or future industries not connected with mining.

1.—TIMBER.

Bearing transportation.

Under "Physical Geography," the *timber belts* were outlined and located. In the manufacture of timber into lumber, transportation is the all important question. As the heavy timber belts are above mid-slope, and as there is no railroad on this side of the river, wagoning to Auburn or to Folsom furnishes the only means of communication with the *market.* Hence, at present, nothing but sugar pine lumber, worth from $50 to $75 a thousand, can be manufactured and transported with profit. This is being done to a limited extent in the woods near Georgetown.

Local Railroad.

It is enough to say, that there are timber resources on this divide which, at some future day, will probably be worth the *money to build* its own railroad, to secure its outlet to market. By this is meant a local, timber railroad, connecting with the Placerville road, perhaps

via Dutch Creek, Rock Creek, or Silver Creek; or with the Central Pacific, not far from Auburn.

The adaptation of railroads to local and special traffic is a problem engaging the active energies of many thousand practical engineers the world over. Where resources exist, therefore, adjacent to a market which can be depended upon, the question of economical transportation by railroad is one which will certainly be solved at an early day. Resources demanding

Nor is it necessary to make figures in regard to the value of the timber resources of the Georgetown Divide, when it is known that their extent is equal to the area of the divide within the bounds specified under "Physical Geography"—roughly, at least 200 square miles of the finest timber in the world. Some of this stands, of course, in inaccessible cañons—probably half. Much of it can be floated easily in large ditches to convenient depots for working up and for transportation. Extent of timber

In the construction of a timber railroad, one road, to connect with the broad-gauge railroads, can, with branch termini, be made to answer for two divides. Two divides

The ownership of timber lands is a matter which will bear figuring upon very soon, as certainly as the material progress of California in general may be depended upon in the next ten years. Timber property.

2.—MANUFACTURING, FROM THE MANUFACTURERS' STAND-POINT.

This subject has been touched upon as affording a market for water. The *conditions* on which wooden manufactures for California and Nevada depend are such, that nothing in this line is likely to be undertaken for years, except under the auspices or encouragement Materal and power.

of companies owning extensive timber lands and water power. With a view to the enhancement of the value of such property, a practical phase of manufacturing has already been touched upon. (V.) From the manufacturers' stand-point it may be said, that here is the *material, ad libitum,* to be had at $1 25 to $2 50 per acre.* The railroad grant covers only about one fourth of the good timber lands of Georgetown Divide, and here is water power unlimited, conveniently situated. There is no toll to be paid on the main ridge road from Georgetown to Sacramento Valley, *via* Salmon Falls. All sorts of *articles manufactured* from wood, such as buckets, staves, barrels, bedsteads, soap-root mattress material, furniture in general, etc., sawed and planed in bulk to be put together below, will easily bear transportation by wagon. If the cost, quality and amount of material, and economy of power are items that can tell decisively in favor of other divides of the Sierra Nevada than the single narrow Central Pacific Railroad Divide, which is already nearly divested of its timber, then the item of transportation upon manufactured articles of the kind described, worth from $200 to $2,000 per ton, is becoming even now a practical question of business inquiry.

What can be made.

Business question.

At Sacramento.

On the subject of *power* to be applied in Sacramento Valley, or Sacramento City itself, for manufacturing purposes, I have stated the capabilities of an extensive water supply, like that owned by the California Water Company. It needs no argument to prove that power so furnished would be of incalculable benefit to Sacramento City. A city with very little good and available agricultural country around it, unaided by irrigation, situated at the head of tide water; the addition of cheap power for manufacturing would furnish the miss-

ing element to make it a flourishing centre for an independent and growing population. In the heart of the great valley, and in full view of the snow-capped Sierra, a city of a hundred thousand permanent, prosperous and happy homes would soon grow up.

3.—AGRICULTURE FROM THE FARMERS' STAND-POINT.

Vigorous men.

Notwithstanding all that has been said concerning the advantages and capabilities of the foot-hills, agriculture in the mountains has not flourished. Notwithstanding the quality of the fruit raised there, its abundance with the aid of a little *certain* irrigation, notwithstanding the established tests concerning profits on fruits, nuts, grapes, berries, wine, there is something wanting which still prevents earnest and able men of good business capacity from taking hold of agriculture in the mountains.

Homes for.

The *trouble* is, that practical people cannot afford to devote their time to improvements when they are to be at the mercy of chance, or at the whim of others, after they have succeeded in making a property and a home worth having.

Diversified farming.

Were it necessary, it would be easy to state numerous examples of the profits of *stock* summered in the high Sierras, the owners of which live in the foot-hills. These people are not independent in their foot-hill homes, because they have not what can be called permanent homes, where they reside a greater portion of the year. Give them the guarantee or the ownership on any terms, on shares or otherwise; of water to irrigate from ten to forty acres for every five hundred or six hundred acres of grazing, or vineyard, or nut-tree land owned—the means, in short, of carrying on diver-

sified agriculture, such as our fathers carried on in the east, in fruit, nuts, neat-cattle, sheep, Angora goats, butter, cheese, etc., and before many years run by, there will be a reflux of agricultural population, instead of the continued depopulation of the mountain counties. A better class of plodding, steady farmers, who only undertake to make property, and to build up homes when they can see their *way clear* for themselves and for posterity, will take the place of that nomadic race of miners of the early days, which has now very nearly passed into history.

4.—COMMUNICATIONS.

Road of the Period

For agriculture as well as for manufacturing, transportation is one of the vital questions. Since the railroad is in a land of grand distances and of intervening barren regions, of remote situations like the Pacific slope, emphatically the "road of the period," there is no help for us, but we must have railroads everywhere.

"Aiding railroads."

The history of El Dorado County, in the matter of "aiding railroads," offers a queer comment upon the abuses of legislation, wherein the public communications were partially paid for by the people, resulting in defeating the ends of the people and of the monopolists of the public highways alike.

The sheriff and the rails

El Dorado County is now so deeply in debt, in consequence of having voted subsidies for railroads, that, at the time of my visit the Board of Supervisors, as representatives of the county, had been compelled for some months to disorganize, in order to escape the legal processes of the Central Pacific Railroad Company, brought in judgment against them for liabilities, which the impoverished county was unable to meet. The only factotum of the county left was the county clerk. The stricken county offers so little traffic for its

railroad from Sacramento to Shingle Springs, that there has been a standing threat from the railroad company, on the plea of inadequate traffic, to take up the iron rails, and abandon the road.

Prairie schooner

The prairie schooner and the stage line are to supersede the "road of the period," and so avenge themselves for having been crushed out of existence by the subsidies of the people in favor of railroads.

Private vs. public interest

The public communications must, from motives of policy, if not of justice to the people, be *absolutely controlled* by the people in their own interest, if not owned by them. The laws or precedents which make these communications private property have everywhere become, sooner or later, an unbearable outrage to the community concerned. The salvation of El Dorado County now depends upon two contingencies:

Salvation

1. Whether the State will help it pay its debt;

2. Whether the county shall have vitality enough left to secure again in the lifetime of a generation, the control of her ordinary public communications, on which every interest is dependent.

Both of these questions have been answered by events in the affirmative. [See laws of 1873-4.]

VII.—FINANCIAL AND STATISTICAL.

1.—OTHER PROPERTY OWNED BY THE CALIFORNIA WATER COMPANY.

(1.) 10 lots in Georgetown.

(2.) Brick Water Office, Georgetown; safes, furniture, etc.

(3.) Dwelling-house occupied by the Superintendent (Mr. Bradley).

(4.) A house and lot at the reservoir, near Georgetown.

(5.) Various buildings and improvements for the accommodation of employees along the lines of ditches; Jones' house at the Davis reservoir; the Gorman House above Tunnel Hill; house at Pilot Creek reservoir; Frazer's Camp, head of Pilot Creek, Hanna's Camp on the Little South Fork, at the head of the Little South Fork Ditch. These are all good and substantial buildings, which will last for a century.

(6.) Lots at various points, located for reservoirs, which may be desirable or required in future.

(7.) The Richardson ranche, situated at the head of Mount Gregory ridge.

(8.) Timber locations.

(9.) Water locations on the Rubicon and elsewhere.

(10.) Mining locations.

(11.) A very complete set of surveying instruments and engineering tools.

2.—COSTS OF MATERIALS, DITCHING, FREIGHT, LABOR, ETC.

LUMBER—$12 to $17 per thousand at the mill.

FREIGHT—From Auburn to Georgetown, 50 cents per hundred; from Sacramento to Georgetown, $4.50.

WAGES—$2.50 per day; $30 to $40 per month and found; miners, above ground, $2.50; under ground, $3.

EXCAVATING, by Chinese labor, under contract, has been done at the rate of $2.50 per yard of ditch 3 feet deep, 6 feet on top, and 4 feet at the bottom.

WATER is sold at 10 cents per inch per day of 10 or 11 hours; 20 cents per inch for 24 hours.

3.—EL DORADO COUNTY STATISTICS.

The following figures are compiled from the returns of the County Assessors of El Dorado County, for 1872 and 1873. Being taken in connection with, and as a foundation for, the levy of taxes, they are always, under some heads considerably under the mark, and under others, perhaps, a little over:

Just half, as near as can be estimated by the eye, of the county is comprised in Georgetown Divide; a proportion which accordingly represents the county north of the South Fork of the American to, and including, Lake Valley (Tahoe); the other half constituting Placerville Divide. For convenience of comparison, all the figures for 1872, are given first, those for 1873, immediately following, and enclosed in parentheses. Georgetown and Placerville Divide

Such comparison will show at once the progress made, and serve as a check on defective returns; thus furnishing the data for a pretty good guess at the average truth. The Assessor for 1873, did not stop to count The average truth.

so many trees as his predecessor of 1872, but discovered, on the other hand, that they were making a good deal of butter in the high Sierra. The number of Angora goats has increased; but other stock is less numerously counted in 1873. The number of registered voters shows a decided decrease of population, while the poll-tax receipts would indicate a slight increase in the population. The assessed value of real estate, in 1873, is considerably larger than in 1872, but not so the total valuation.

ASSESSED VALUE OF PROPERTY OF EL DORADO COUNTY. —Real estate, $414,327; ($479,471). Improvements, $911,088, ($777,315). Personal property, $1,077,038; ($864,245). Total valuation, $2,402,453; ($2,121,031).

POPULATION —Estimated total, 9,600; (9,220). Registered voters, 4,624; (2,800). Poll-taxes collected in 1871, $2,725; in 1872, $2,844.

MINING AND MINING DITCHES.—Number of quartz mills, 40; number of mining ditches, 54; miles in length, 850. Amount of water used per day, in inches, 6,720.

IRRIGATION.—Irrigating ditches, 27; (20). Acres irrigated, 1,320; (1,320).

RAILROADS.—There is but one railroad, the Sac. Valley, having a length of 18¾ miles. The Central Pacific Railroad, however, runs along one end of the county for 20 miles, within a few miles of the boundary; and the county not only contributed towards its construction, but has one third of its lands doubled in price, in consequence of the United States land grant donated in aid of the Central Pacific Railroad.

GRIST MILLS.—Steam power, 1; water power, 2; (1).

SAW MILLS.—Steam power, 8; water power, 2. Feet of lumber sawed, 1,282,900.

DISTILLERIES, (6).

Stock, etc.—Sheep, 10,594; (13,417). Cashmere and Angora goats, 68; (280). Hogs, 2728; (2074). Beehives, 368. Horses, 1,924; (1,448). Mules, 158; (107). Asses, 21; (12). Cows, 4,340; (3,817). Calves, 1,480; (1,060). Beef cattle, 4,554; (3,861). Oxen, 220; (167). Total neat cattle, 10,594; (8,905).

Vines and Wine Manufacture.—Vines, 1,571,196; (1,444,950). Gallons of wine manufactured, 192,865; (103,060). Gallons of brandy manufactured, 6,665; (3,320).

Breweries, 4.

Fruit and Nut Trees —Figs, 985; (578). Mulberry, 5,415. Almond, 219; (133). Walnut, 119. Apple, 85,724; (81,581). Peach, 42,993; (25,591). Pear, 9,297; (22,930). Plums, 11,763; (8375). Cherry, 2,295; (1,511). Nectarine, 967; (892). Quince, 763; (424), Apricot, 341, (196).

Acres of Land Enclosed in 1871, 41,252; cultivated in 1871, 10,447. Enclosed in 1872, 68,000; cultivated in 1872, 10,643.

Wheat.—Acres, 747; (502). Bushels, 5,224; (4,321).

Barley.—Acres, 321; (619). Bushels, 3,089, (6,023).

Oats.—Acres, 218, (150). Bushels, 800, (718).

Rye.—Acres, 166. Bushels, 401.

Corn.—Acres, (40); bushels, (113).

Hay.—Acres, 3,769; (3,557). Tons, 1,252, (1,724).

Miscellaneous Farm Produce.—Butter, lbs, 1,060; (12,176). Cheese, 700; (794). Wool, lbs., 1,100; (6,-205). Honey, lbs., 423.

Potatoes.—Acres, 90, tons, 6,120.

VIII.--PRACTICAL CONSIDERATIONS.

1.—Situation.
2 —Advantages.
3.—Operations.
4 —Partial Execution of the Plan.
5 —Development of Mining Properties.
6.—Policy in Regard to Agriculture
7 —Sacramento Valley and City Water Supply.
8.—Manufactures.
9 —Possibilities.
10 —Policy in Regard to Extension.
11.—Interest on Investments, and Dividends.
12 —Various Suggestions.

1. THE SITUATION.

The property of the California Water Company, in ditches, mines, and lands, owned or controlled is immense.

What is required to make the most of the situation is a keen perception of values within reach, and proven by actual test.

In horticulture, agriculture, mining and manufactures it is left to the water company to *foster general prosperity*, and to reap its principal results.

DECADENCE AND REVOLUTION.

In grasping the idea of the situation, the status of the Divide is significantly represented by the census reports, taken by decades. In 1850 El Dorado county had a population of 20,000; in 1860, 20,500; and in 1870, only 10,300. The same proportion holds true in Amador, Calaveras and Placer counties. That is to say, there is now *only half* the population in the country; and of this half the proportion actually engaged in mining is probably more fairly stated at *one tenth*. Kel-

'sey's had 1200 people in 1860, and but 300 in 1870; Greenwood, 1000 in 1860, and only 550 in 1870; Big Bar Township, 1100 in 1860, and none in 1870.

Yet the gold product of California has decreased only 60 per cent. from the highest it has ever been; and all of it is produced from deposits that were abandoned by the miners of the heroic period because they *would not pay*. El Dorado county must have produced one tenth of the $600,000,000 of gold produced by California before 1860, or $60,000,000, of which Georgetown Divide produced half.

The revolution that has taken place elsewhere has been "dragging its slow length along" also on Georgetown Divide.

Decadence and dilapidation, in shanties and tatters; in stranded human waifs; in ruins, suggestive of lawless activities and heroics, in those Troys and Pompeiis of the period — Johntown, Kelsey's, Volcanoeville and Mt. Gregory, where now everything is serenely dead—the logic of events branded into the unsuccessful average miner's soul, and coined into the words "exhausted" and "mined out." This lowest trough of the great sea of population which had risen as high as the Sierra, has *imperceptibly* passed us in California, so that it remains still necessary to point out definitely and fully the substantial resources of the country, before it can be expected to be believed that all the gold California has to give, did not lie upon the surface.

They have had no water on Georgetown Divide to sluice systematically. The veins and seam belts have not been understood to be worked discriminatingly. The natural wealth which maintained in El Dorado county for the first ten years of our history, the largest

population of any county in the State, is evidently still there, and not far under the surface.

2.—ADVANTAGES.

Development of properties

The California Water Company's chief advantage lies in the fact that the water, which costs them nothing beyond ditching and fluming, may serve them in the place of money, and quite as effectually, in procuring for them great dividend yielding properties, either wholly or, (if preferred,) only cooperatively conducted, or owned by them.

Under this view of the situation, the mines and other resources of Georgetown divide can call into requisition at once and pay for all the water that all the ditches, completed or projected, can possibly deliver.

History

To counterbalance the former richness of the gulch and river placers, so successfully worked here between 1849 and 1856—placers which could be only once deposited and once exhausted in a geological epoch—you have now at your command: 1. A perfect knowledge of the localities that were richest in gold, the sources of deposits proven to be worthy of systematic exploitation. 2. The experiences of twenty-five years of gold mining in general; 3. All the improvements in appliances, machinery and method developed in other portions of the State.

3.—OPERATIONS.

Perennial supplies

The completion of your canal to the Little South Fork this summer, and the utilization of the stores of Loon Lake Basin, will place this company with all its distributing ditches in a position commanding a larger area of valuable mining, agricultural and timber lands than any other corporation of the sort in California, or

in the United States. City water supply, the primary object of most large water companies, is to you a no less promising object of revenue, and one no less certain of attainment than if it had been the primary object of your incorporation; yet it is only an incidental feature of a grand system of developments, vastly more important, broader, and much more interesting, in view of all the possibilities of expansion which are pointed out elsewhere in this Report. Sacramento valley.

4.—PARTIAL EXECUTION OF THE PLAN.

It should be understood that the California Water Company has only commenced to do that which is in process of execution, the benefits from which can not be anticipated before the plan on which you have based your organization shall have been further carried out. Anticipated prosperity

The abundant, unfailing summer supply of water requisite, with its application to prosperous mining and prosperous agriculture, wherever the divide affords conditions worthy of such application, are but partially attained.

The water sales have heretofore been made chiefly in the winter season, and extending into the summer to June. After that they have fallen off. The Pilot Creek Ditch supply has fallen off to one hundred inches during the latter part of the summer and fall. During the coming season, (1874, or as soon as the Little South Fork ditch is completed,) the supply will be constant through the summer, and the water sales may even exceed those of the winter. [For "Summer Supply,' see under Ditches, Little South Fork Section, and Loon Lake Reservoir.]

5.—DEVELOPMENT OF MINING PROPERTIES.

Par

If the possession of this water, and that alone, as a prospecting or developing agency, can furnish you title to mines individually worth more than all that has been laid out in the operations of the Company, it may be worth your while to consider a little more particularly this principle. that water can be turned at will into gold direct, or into a golden entering wedge of investment as good as par under any circumstances. Under intelligent management, based upon a thorough knowledge of the character of the mines and the results of the experience and expenditures of others in prospecting, it would be no difficult matter at all to designate a number of localities where water, which is already at command in quantities, and under pressure, could be made to disclose rich deposits, showing every probability of continuance into depth.

Risks.

If the California Water Company is not already a mining company *as much* as a water company, it can become such without taking the usual risks of miners, in prospecting and opening and testing ground of suspected or proven wealth.

Prospecting

One course which would insure to you all the beneficial results from risks undertaken by others, and quite as thoroughly as if all were under your own direction, control and expense, would be to furnish the miners with the means of prospecting. especially in winter time; or perhaps with lengths of claim pipe, of which there ought to be transportable extras in quantity always at hand; or occasionally, indeed, to advance supplies in part, if that were necessary to accomplish desired explorations, allowing the miner say one half, for his portion of the work of discovery and development.

The Water Company should own a team and lumber wagon to transport such pipe and other articles from one locality to another in order to facilitate undertakings in ground believed or known to be rich, yet lying idle. All the initial difficulties in the way of development would be thus swept aside at the expense of a little forethought, and without any outlay by the Company worth mentioning; yet all would be done under their own direction and control, and for their own benefit. Initial drawbacks.

When a mine eventually changes from a hydraulic mine to an *underground mine* of a paying character, the furnishing of water *power*, and a turbine wheel for hoisting and pumping would be a small item to set against securing, in any mine worth having, a half interest or one half of the yield. Power.

(6.)—POLICY IN REGARD TO AGRICULTURE.

Steps should be taken calculated to inaugurate agricultural prosperity on the Divide. This can only be done by opening the way to agricultural independence—the only inducement for vigorous men to locate—hence the only road to market for water in this direction. Agricultural independence.

By furnishing water to the horticulturist and stock farmer, you may, on general principles, share in the proceeds of all the most promising undertakings in this line adapted to the conditions of the country.

Permanent agriculture implies cheaper supplies of every kind; therefore economy in mining, in local manufactures, and other undertakings generally.

7.—SACRAMENTO VALLEY AND CITY WATER SUPPLY.

Waters once used

If you would take full advantage of your position you should catch up your water again in the middle and North Fork of the American below their junction, for application in the foot-hills valleys, bordering on Sacramento Valley between Roseville and Folsom, or in the great valley itself, as far down, if you choose, as Sacramento City.

Valley section

This can be done at a very moderate cost, by purchasing or connecting with the ditches of the American River Company, reaching within ten miles of Sacramento, and commanding a region skirting the foot-hills for six miles along the south branch of Antelope Creek; and, in fact, every acre of land worth tilling, from the north bank of the American to the Central Pacific Railroad. The height of the Reamer Ditch, above the American River, opposite Wild Goose, is about 100 feet. It would take probably 500 feet of pipe to turn the Wild Goose Ditch into the American River Ditch.

City supply.

Using the American River Company's Ditch, with its abundant summer supply, for systematic irrigation in the valley wherever rich lands are commanded by it, the investment could not be otherwise than safe. But the primary and chief advantage of possessing this property lies in the possibility of turning the ditch at any time into a conduit for clear water from your main ditch via Georgetown, Greenwood, and Wild Goose, to Sacramento City.

Pipe across American.

A pipe from the left bank of the American, near Wild Goose Flat to the American River Company's Ditch, on the right bank; the construction of a few large reservoirs for city supply, near the terminus of the

American Company's Ditch, 150 or 200 feet above Sacramento; and ten to twelve miles of eighteen-inch or two feet pipe, would be the only preliminaries to enable you to secure, at the proper time, the ever-growing market of the Capital city.

Your company being so situated, the supply of Sacramento City must, sooner or latter, fall into your hands, for the reason that it is clear water from the mountains you are able to furnish; and because you can undersell, and force out any system of city supply which involves the expenses of pumping.

The practicability, policy, and economy of incorporating this as a subordinate plan of operations into your general scheme, may be further deduced from particulars referred to under *Power and Valley Market*, Subdivision V.

8.—POLICY OF THE COMPANY IN REGARD TO EXTENSION.

In order to secure the water supply of Sacramento, it is only necessary to be *ready* to respond when the call shall come. Using the American River or Valley section, as already constructed for irrigation, you have only to connect your pipe with Wild Goose Flat, and so with your Loon Lake ditches and reservoirs. **Opportunity**

After you have obtained a market at Sacramento, you can give the city the first chance. A new ditch, for the separate and special accommodation of the agricultural interest, can be dug at a time during the winter season when that interest would not suffer from interruption.

In a similar manner, it should be the policy of the company to connect the Rubicon River with Loon Lake Basin at such time as the further development of the **Rubicon.**

agricultural or mining market of the Georgetown divide may be prepared for it.

The Rubicon basin is timbered in spots with sugar pine, spruce, fir, and tamarack, which could be sawn into flume lumber. Ten miles of ditching and fluming will connect the Rubicon with your present system.

9.—MANUFACTURED PRODUCTS

Will bear transportation

Will easily bear transportation to the valley, where the raw product is, and might for a century remain, worthless; for the simple reason that a ton of the raw material will bring from $20 to $50 in the market, while a ton of the manufactured product will command from $100 to $1,000. The margin of loss in transportation becomes proportionately insignificant.

The lumber resources of the divide, outside of sugar pine, available at the present time, it is obvious can only be taken advantage of in this way.

This is not a question, certainly, of working a placer, but of turning to the best account the resources and conditions of the situation, for years to come, with comparatively insignificant outlays, and returns fair in a business sense, while possessing the element of certainty to a large degree.

Timber land

By purchasing valuable timber lands adjacent to falls in the ditches, or other points where the water would be caught up in a lower ditch, the Company can create valuable properties without any cost to themselves further than the outlay of $1.25 per acre.

The primary advantage of pursuing such a course would be the cash realized; the secondary and permanent one, the increased local agricultural demand for water, on a cash basis, that would spring up wherever men are employed, and families must reside.

10.—POSSIBILITIES.

Should there appear to be justification in the future for the construction of a narrow gauge railroad to Placerville, or a branch up Dutch Creek on Georgetown Divide, a matter not by any means beyond the bounds of possibility, the timber resources of Georgetown Divide will become valuable for lumbering in general. Road.

11.—VARIOUS SUGGESTIONS

I have not attempted to sum up, as a lawyer might do in his brief, from the "evidence" preceding this chapter, the entire business aspect of the case. Many practical suggestions have occurred to me with force, which are omitted. It has been my aim to point out to the stockholders of the California Water Company what they have on Georgetown Divide. Knowing this perhaps better than heretofore, their own ideas will be good enough as to what they had better do with it.

Signal telegraphs ought to be constructed, to supplement the existing short magnetic line. *Sulphurets* ought to be separated in the sluices, saved and concentrated by the most approved methods. For this, you possess the necessary water power, and are under the most favorable conditions imaginable. In the metamorphic greenstones of the American mine, (at C., Fig. 12, p. 45,) I found free gold, associated with the iron pyrites, in flakes and bunches plainly visible. From the manner of the formation of gold in veins, (see tabular exhibit, and Sub. IV.,) most of it must have been deposited in connection with iron sulphurets, metallic, probably, but in a very finely divided condition. It is necessary, therefore, to separate the sulphurets, accompany-

ing any noteworthy deposit, and treat them by roasting and chlorination.

How far auxiliary treatment by milling, concentration or chlorination would pay, may be deduced from the table showing expenses of mining, etc.

If rock containing 2 per cent. of sulphurets can be mined and milled with the aid of water for $1 to $2 per ton, a ton of sulphurets would cost $50 to $100 for mining; $12.50 for concentrating, and $11 for chlorinating; making a total cost of $75 to $125 for working sulphurets worth (not less than) $200; or a clear profit of $75 to $125 per ton of sulphurets worked.

This would be, from ten tons of sulphurets per day—or 500 tons of rock, a quantity easily excavated with one hydraulic head—a net yield of $750 to $1250 per day.

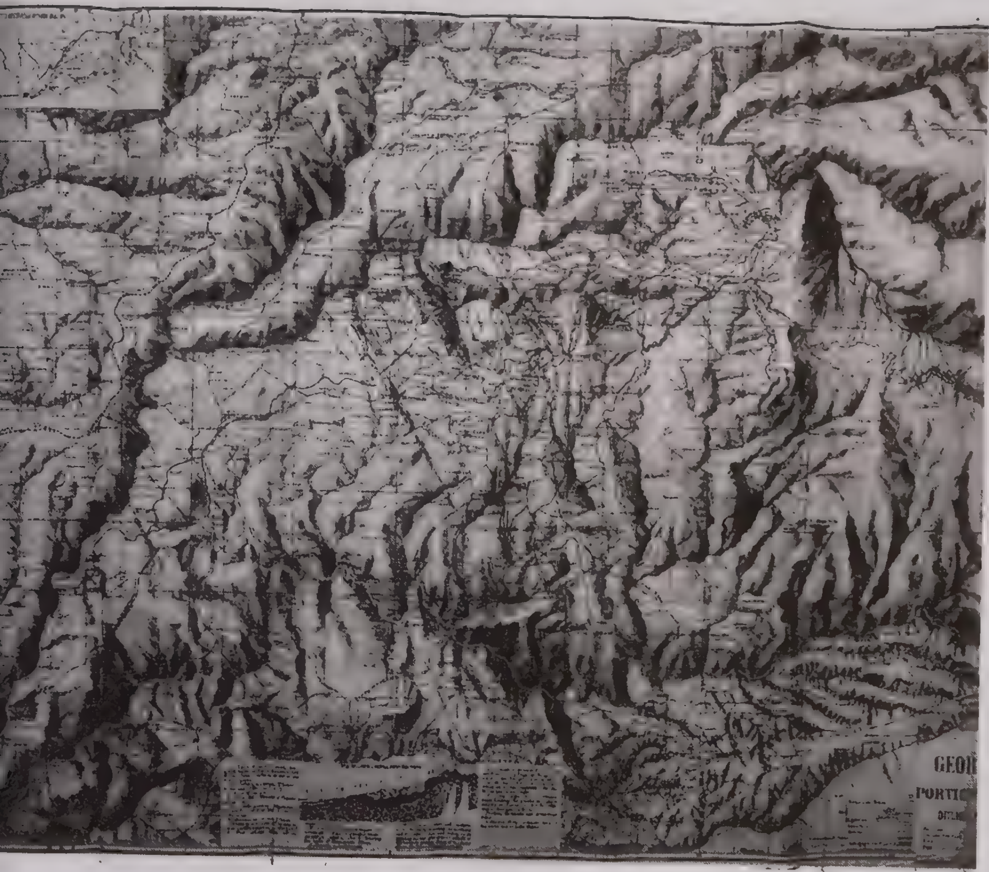
If, in the above calculation, the item of mining and milling be placed as low as 30 cents per ton—a liberal allowance for hydraulic excavation in the seam diggings, including disintegration and ruder sortings—the result would be over $1500 per day profit. How much of the last named figure would have to be drawn upon to meet the ordinary item of crushing, would of course depend upon the nature of the rock.

12.—INTEREST AND DIVIDENDS.

It has not been my duty specially to ascertain the sums actually invested by the present stockholders of the California Water Company, nor to speculate upon what various resources, when developed, may yield them in dollars per annum.

These matters are essentially private, if the figures attainable are at all definite. I have shown that the possibilities, from such resources, are unlimited. The results must depend upon the degree of energy and

executive talent that may be applied, with investments adapted to the conditions of the country. That a fair interest upon the investments already made, or immediately contemplated, so far as I know them, may be expected under ordinary good management, I believe no one carefully acquainting himself with the resources and facts herein set forth, will doubt.



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